***DRAFT***
**COMPREHENSIVE CONSERVATION PLAN**
**AND**
**ENVIRONMENTAL ASSESSMENT**

# MACKAY ISLAND NATIONAL WILDLIFE REFUGE

*Currituck County, North Carolina*
*and Virginia Beach, Virginia*

**U.S. Department of the Interior**
**Fish and Wildlife Service**
**Southeast Region**
**1875 Century Boulevard**
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## EXECUTIVE SUMMARY

The U.S. Fish and Wildlife Service prepared this Draft Comprehensive Conservation Plan and Environmental Assessment to guide the management of Mackay Island National Wildlife Refuge in Currituck County, North Carolina, and Virginia Beach, Virginia. The plan outlines programs and corresponding resource needs for the next 15 years, as mandated by the National Wildlife Refuge System Improvement Act of 1997.

Before the Service began planning, it conducted a biological review of the refuge's wildlife and habitat management program and conducted public scoping meetings to solicit public opinion on the issues the plan should address. The biological review team was composed of biologists from federal and state agencies and non-governmental organizations that have an interest in the refuge. The staff held the public scoping meetings at four locations on four evenings. Another round of public meetings was held to solicit public reaction to the proposed alternatives.

The Service developed and analyzed three alternatives. Alternative 1 was a proposal to maintain the status quo. The refuge currently manages its impoundments very intensively by managing water levels and vegetation to create optimum habitat for migrating waterfowl. It also manages marshes with prescribed fire. The staff surveys waterfowl on a routine basis. The refuge allows the six priority public use activities: hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation. The staff conducts environmental education and interpretation on a request basis only. A staff of seven members is stationed at Mackay Island Refuge. They spend 415 full-time equivalent (FTE) staff years on Mackay Island Refuge and 2.85 FTE staff years at Currituck National Wildlife Refuge.

Alternative 2 proposed moderate program increases. The staff would develop a habitat management plan and manage all habitats on the refuge. The staff would survey a wide range of wildlife on the refuge. The refuge would continue to allow the six priority public use activities, but would have the capacity to increase the number of opportunities. The staff would conduct regularly scheduled environmental education and interpretation programs. The Service would build an environmental education center. There would be fifteen staff members - eleven stationed at Mackay Island Refuge and four stationed at Currituck Refuge. They would spend 7.8 FTE staff years at Mackay Island Refuge and 7.2 FTE at Currituck Refuge. The staff would include a biologist and public use specialist.

Alternative 3 proposed substantial program increases. The staff would develop a habitat management plan and manage all habitats on the refuge. The staff would survey all wildlife on the refuge. The refuge would increase further the number of public use opportunities. The Service would build an environmental education center. There would be twenty-four staff members - seventeen stationed at Mackay Island Refuge and seven stationed at Currituck Refuge. They would spend 11.25 FTE staff years at Mackay Island Refuge and 12.75 FTE at Currituck Refuge. The staff would include separate law enforcement officers and public use specialists for Mackay Island and Currituck Refuges.

The staff selected Alternative 2 as the preferred alternative. It advances the refuge program considerably, and is more realistic than Alternative 3 in terms of expected staffing levels to conduct the proposed program.

**SECTION A. DRAFT COMPREHENSIVE CONSERVATION PLAN**

# *I. Background*

## INTRODUCTION

The Fish and Wildlife Service developed this Draft Comprehensive Conservation Plan and Environmental Assessment to provide a foundation for the management and use of Mackay Island National Wildlife Refuge in Currituck County, North Carolina, and Virginia Beach, Virginia. The plan is a guide for the refuge's management programs and actions over the next 15 years.

The plan was in compliance with the National Wildlife Refuge System Improvement Act of 1997 and Part 602 of the Fish and Wildlife Service Manual. The actions described within this plan also meet the requirements of the National Environmental Policy Act of 1969. The staff complied with this act through the involvement of the public and the incorporation of an environmental assessment in this document, with a description of the alternatives considered and an analysis of the environmental consequences of the alternatives (see Chapters III and IV). When fully implemented, this plan will strive to achieve the vision and purposes of Mackay Island National Wildlife Refuge.

The plan's overriding consideration is to carry out the purposes for which the refuge was established. Fish and wildlife are the first priority in refuge management. The Service allows and encourages public use (i.e., wildlife-dependent recreation) as long as it is compatible with, or does not detract from, the refuge's mission and purposes.

A planning team, made up of representatives from various Service programs, including Refuges, Fisheries, Ecological Services, Realty, and Migratory Birds, developed the plan. In developing this plan, the team and staff have incorporated the input of state agencies, non-governmental organizations, local citizens, and the general public through a series of stakeholder and public scoping meetings. This public involvement and the planning process itself are described in the Plan Development chapter.

The plan represents the Service's proposed alternative, which is being presented after considering three other alternatives as described in the environmental assessment. After reviewing a wide range of public comments and management needs, the planning team developed these alternatives in an attempt to determine how to best meet the goals and objectives of Mackay Island National Wildlife Refuge. The proposed alternative is the Service's recommended course of action for the management of the refuge, and is the basis of this comprehensive conservation plan.

## PURPOSE AND NEED FOR THE PLAN

The purpose of this comprehensive conservation plan is to identify the role that Mackay Island National Wildlife Refuge will play in support of the mission of the National Wildlife Refuge System, and to provide long-term guidance to management programs and activities for the next 15 years. The plan is needed to:

Provide a clear statement of direction for management of the refuge;
Provide refuge neighbors, visitors, and government officials with an understanding of the Fish and Wildlife Service's management actions on and around the refuge;

Ensure that the Service's management actions, including land protection and recreational and educational programs, are consistent with the mandates of the National Wildlife Refuge System Improvement Act of 1997;

Ensure that management of the refuge is consistent with federal, state, and county plans; and

Provide a basis for budget requests for operational, maintenance, and capital improvement needs.

Perhaps the greatest need of the Service is to communicate with the public and include public participation in its efforts to carry out the mission of the National Wildlife Refuge System. Many agencies, organizations, institutions, businesses, and private citizens have developed relationships with the Service to advance the goals of the Refuge System. This draft plan supports the Partners-in-Flight Initiative, South Atlantic Coastal Plain Migratory Bird Conservation Plan, North American Waterfowl Management Plan, Western Hemisphere Shorebird Reserve Network, and National Wetlands Priority Conservation Plan.

## FISH AND WILDLIFE SERVICE

The Fish and Wildlife Service is the primary federal agency responsible for the conservation, protection, and enhancement of the Nation's fish and wildlife populations and their habitats. Although the Service shares some conservation responsibilities with other federal, state, tribal, local, and private entities, it has specific trustee obligations for migratory birds, threatened and endangered species, anadromous fish, and certain marine mammals. In addition, the Service administers a national network of lands and waters for the management and protection of these resources.

As part of its mission, the Service manages more than 540 national wildlife refuges covering a total of more than 93 million acres. These areas comprise the National Wildlife Refuge System, the world's largest collection of lands and waters specifically managed for fish and wildlife. The majority of these lands, 77 million acres, lie in Alaska. The remaining 16 million acres are spread across the other 49 states and several island territories.

## THE NATIONAL WILDLIFE REFUGE SYSTEM

The mission of the Refuge System, as defined by the National Wildlife Refuge System Improvement Act of 1997, is:

... to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

The National Wildlife Refuge System Improvement Act of 1997 established, for the first time, a clear mission of wildlife conservation for the National Wildlife Refuge System. The act states that the Service shall manage each refuge to:

- Fulfill the mission of the Refuge System;
- Fulfill the individual purposes of each refuge;
- Consider the needs of fish and wildlife first;

- Fulfill the requirement of developing a comprehensive conservation plan for each unit of the Refuge System, and fully involve the public in the preparation of these plans;

- Maintain the biological integrity, diversity, and environmental health of the Refuge System;

- Recognize that wildlife-dependent recreation activities, including hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation, are legitimate and priority public uses; and

- Retain the authority of refuge managers to determine compatible public uses.

Following passage of the Act in 1997, the Service immediately began efforts to carry out the direction of the new legislation, including the preparation of comprehensive conservation plans for all refuges. The development of these plans is now ongoing nationally. Consistent with the act, all refuge comprehensive conservation plans are being prepared in conjunction with public involvement, and each refuge must complete its own plan within a 15-year schedule.

Approximately 37.5 million people visited the country's national wildlife refuges in 1998, mostly to observe wildlife in their natural habitats. As this visitation continues to grow, substantial economic benefits are being generated to the local communities that surround the refuges. Economists have reported that national wildlife refuge visitors contribute more than $400 million annually to the local economies. In addition, the National Survey of Fishing, Hunting, and Wildlife Associated Recreation reports that nearly 40 percent of the country's adults spent $108 billion on wildlife-related recreational pursuits in 2001 (U.S. Fish and Wildlife Service 2001).

Volunteerism continues to be a major contributor to the successes of the Refuge System. In 1998, volunteers contributed more than 1.5 million person-hours on the refuges nationwide, a service valued at more than $20.6 million.

The wildlife and habitat vision for the national wildlife refuges stresses the following principles:

- Wildlife comes first.

- Ecosystems, biodiversity, and wilderness are vital concepts in refuge management.

- Refuges must be healthy.

- Growth of refuges must be strategic.

The National Wildlife Refuge System serves as a model for habitat management with broad participation from others.

## LEGAL POLICY CONTEXT

A variety of international treaties, federal laws, federal regulations, Department and Service Policies, and Presidential executive orders guide the administration of Mackay Island National Wildlife Refuge. The documents and acts listed in Appendix III contain management options under the refuge's establishing authority and the National Wildlife Refuge Administration Act of 1966 and National Wildlife Refuge System Improvement Act of 1997 (the legal and policy guidance for the operation of national wildlife refuges).

## NATIONAL CONSERVATION PLANS AND INITIATIVES

Along with the Service's legal mandates and initiatives, other planning activities directly influence the development of the comprehensive conservation plan. Various groups and agencies develop and coordinate planning initiatives involving federal, state, and local agencies; local communities; non-governmental organizations; and private individuals to help restore habitats for fish and wildlife on and off public lands.

The Service is initiating cooperative partnerships in an effort to reduce the declining trend in biological diversity. Biological planning for species groups targeted in this plan reflects the North American Waterfowl Management Plan. The North American Waterfowl Management Plan of 1986 brings together international teams of biologists from private and governmental organizations from Canada and the United States. The partnerships, called joint ventures, are working to restore waterfowl and other migratory bird populations to the levels of the early 1970s by protecting about 6 million acres of priority wetland habitats from the Gulf of Mexico to the Canadian Arctic.

The United States Shorebird Conservation Plan and Waterbirds for the Americas outline approaches to conserving those species groups. Restoration of migratory songbird populations is a high priority of the Partners-in-Flight Plan. It also provides strategies for conserving and managing wintering, breeding, and migrating habitat for mid-continental wood duck and colonial bird populations.

The Partners-in-Flight Plan emphasizes land bird species as a priority for conservation. Habitat loss, population trends, and the vulnerability of species and habitats to threats are all factors used in the priority ranking of species. Further, biologists have identified focal species for each habitat type from which they will determine population and habitat objectives and conservation actions. This list of focal species, objectives, and conservation actions will aid migratory bird management on the refuge.

The Farm Bill programs administered by the United States Department of Agriculture provide cost-share funding and technical assistance to private landowners to install and manage conservation practices on working farms and forests and restore cropland to natural habitats. The programs provide opportunities for landowners in the vicinity of national wildlife refuges to manage their land better as wildlife habitat or protect it with easements.

Along with the Service's legal mandates and initiatives, numerous planning activities directly influence the development of the comprehensive conservation plan. Other federal, state, and local agencies; local communities; and non-governmental organizations develop and coordinate planning initiatives. These initiatives involve land owned by the agencies, organizations, and private individuals to help restore habitats for fish and wildlife on and off public lands.

The Service is initiating cooperative partnerships in an effort to reduce the declining trend in biological diversity. Biological planning for the species groups targeted in this plan reflects the Partners-in-Flight Plan, North American Waterfowl Management Plan, North American Waterbird Conservation Plan, and the U.S. Shorebird Conservation Plan.

The South Atlantic Coastal Plain serves as a primary migration habitat for migratory songbirds returning from Central and South America. It also provides wintering, breeding, and migration habitat for mid-continental wood duck and colonial bird populations. Restoration of migratory songbird populations is a high priority of the Partners-in-Flight Plan.

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which they will determine population and habitat objectives and conservation actions. This list of focal species, objectives, and conservation actions will aid migratory bird management on the refuge.

## RELATIONSHIP TO STATE PARTNERS

A provision of the National Wildlife Refuge System Improvement Act of 1997, and subsequent agency policy, is that the Service shall ensure timely and effective cooperation and collaboration with other federal agencies and state fish and wildlife agencies during the course of acquiring and managing refuges. This cooperation is essential in providing the foundation for the protection and management of fish and wildlife throughout the United States.

The North Carolina Wildlife Resources Commission (NCWRC) and the Virginia Department of Wildlife and Inland Fisheries are the state-partnering agencies with the Service, charged with enforcement responsibilities for migratory birds and endangered species, as well as managing the state's natural resources. The North Carolina Wildlife Resources Commission also manages approximately 1.8 million acres of game lands in North Carolina. The Virginia Department of Wildlife and Inland Fisheries manages approximately 192,000 acres of wildlife management areas in Virginia.

The state fish and wildlife agencies coordinate the state's wildlife conservation program and provide public recreation opportunities, including an extensive hunting and fishing program, on several game lands and from several boat ramps located near Mackay Island Refuge. The agencies' participation and contribution throughout this comprehensive conservation planning process have been valuable, and they are continuing its work with the Service to provide ongoing opportunities for an open dialogue with the public to improve the condition of fish and wildlife populations in North Carolina and Virginia. Not only have the agencies participated in biological reviews, stakeholder meetings, and field reviews as part of the planning process, they also are active partners in annual hunt coordination planning, and various wildlife and habitat surveys. Mackay Island Refuge provided hunting opportunities for deer and waterfowl in cooperation with the agencies. A key part of the comprehensive conservation planning process is the integration of common mission objectives between the Service and the state agencies, where appropriate.

# *II. Refuge Overview*

## INTRODUCTION AND HISTORY

Mackay Island National Wildlife Refuge is in Currituck County, North Carolina and Virginia Beach, Virginia. The Service named the refuge for Mackay Island where it is located, which is, in turn, named for John Mackie, who once owned the island. The approved acquisition boundary lies in Currituck County, North Carolina (population 18,190) and the city of Virginia Beach, Virginia. The southern end of the city of Virginia Beach, Virginia (population 425,257), lies at the northern end of the refuge; the closest developed area of the city lies 18 miles north of the refuge; the center of the city lies 27 miles north of the refuge. The center of the city of Chesapeake, Virginia (population 199,184), lies 27 miles northwest of the refuge and the center of the city of Norfolk, Virginia (population 234,403), lies 31 miles northwest of the refuge (Figure 1). The refuge covers a total of 8,219 acres and its western boundary is on the North Landing River just northeast of its outlet into the Currituck Sound and just south of Back Bay. This region is part of the physiographic area known as the South Atlantic Coastal Plain and the Fish and Wildlife Service administrative ecosystem known as the Roanoke-Tar-Neuse-Cape Fear Ecosystem.

## REFUGE HISTORY AND PURPOSES

Congress established the Mackay Island National Wildlife Refuge on December 30, 1960, by the authority of the Migratory Bird Conservation Act of 1929. The Service established the original acquisition boundary of 7,835 acres in 1961 and expanded the boundary to 9,503 acres in 1991. The Secretary of the Interior issued a proclamation on August 21, 1963, prohibiting waterfowl hunting on 4,621 acres of the refuge and 1,098 acres of water south and west of the refuge.

The proposed acquisitions qualified for funding under the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715R) and the Refuge Recreation Act of 1962 (16 U.S.C. Sec 460k-1).

The refuge's complete acquisition history is in Table 1.

The purpose of Mackay Island National Wildlife Refuge, as reflected in the legislation under which Congress authorized the refuge and the refuge has acquired land, is to protect and conserve migratory birds, and other wildlife resources through the protection of wetlands, in accordance with the following laws:

...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds... 16 U.S.C. Sec. 664 (Migratory Bird Conservation Act of 1929);

...for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species... 16 U.S.C. Sec 460k-1 (Refuge Recreation Act of 1962).

The North American Waterfowl Management Plan's Atlantic Coast Joint Venture office, working through a collaborative effort with private, state, and federal agencies, has established certain habitat objectives for the physiographic area.

**Figure 1. The location of Mackay Island National Wildlife Refuge in Currituck County,** North Carolina and Virginia Beach, Virginia.

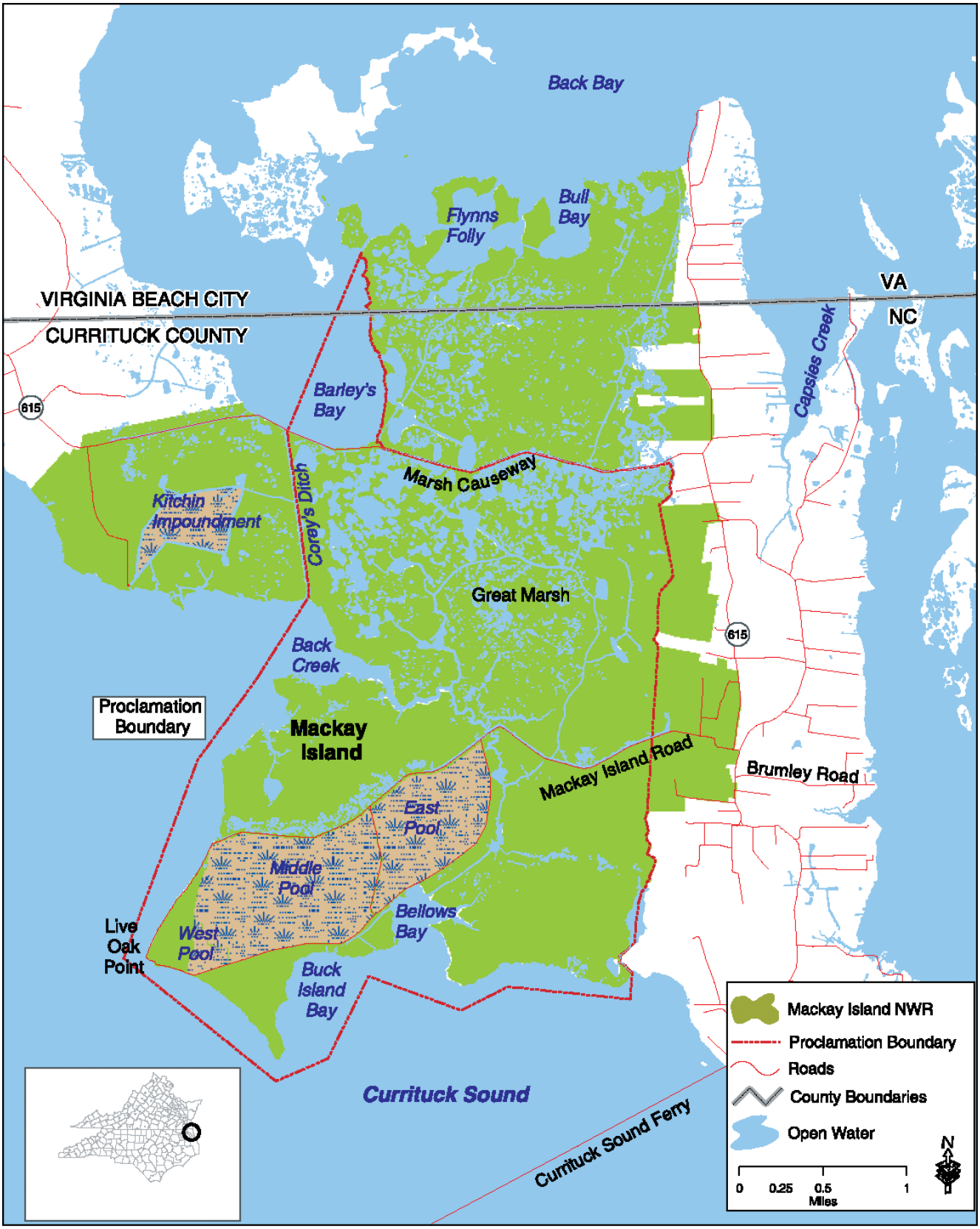


**Table 1. Mackay Island National Wildlife Refuge acquisition history**

| DATE | TRACTS | ACRES | COST | COST ACRE | TOTAL ACREAGE | TOTAL COST |
|---|---|---|---|---|---|---|
| **1960** | 1 | 4,183.65 | $167,346 | $40.00 | 4,183.65 | $167,346 |
| **1961** | 7 | 2,291.03 | $73,199 | $31.95 | 6,474.68 | $240,545 |
| **1962** | 3 | 63.40 | $2,875 | $45.34 | 6,538.08 | $243,420 |
| **1963** | 6 | 114.77 | $37,395 | $325.83 | 6,652.85 | $280,815 |
| **1964** | 16 | 175.17 | $17,357 | $99.09 | 6,828.02 | $298,172 |
| **1966** | 5 | 118.85 | $53,600 | $450.99 | 6,946.87 | $351,772 |
| **1967** | 1 | 27.24 | $14,000 | $513.95 | 6,974.11 | $365,772 |
| **1968** | 2 | 20.75 | $18,600 | $896.39 | 6,994.86 | $384,372 |
| **1969** | 1 | 17.80 | $16,000 | $898.87 | 7,012.66 | $400,372 |
| **1971** | 1 | 11.30 | $14,500 | $1,283.19 | 7,023.96 | $414,872 |
| **1977** | 1 | 32.10 | $1,040 | $32.39 | 7,056.06 | $415,912 |
| **1985** | 2 | 54.80 | $101,350 | $1,849.45 | 7,110.86 | $517,262 |
| **1992** | 1 | 72.00 | $31,000 | $430.56 | 7,182.86 | $548,262 |
| **1993** | 1 | 636.73 | $0 | $0 | 7,819.59 | $548,262 |
| **1994** | 3 | 205.15 | $0 | $0 | 8,024.74 | $548,262 |
| **2000** | 2 | 21.17 | $130,000 | $6,140.77 | 8,045.91 | $678,262 |
| **2001** | 3 | 91.83 | $375,600 | $4,090.17 | 8,137.74 | $1,053,862 |
| **2003** | 2 | 81.42 | $438,400 | $5,384,43 | 8,219.16 | $1,486,182 |
| **Total** | **58** | **8,219.16** | **$1,486,182** | **$180.81** | | |

## SPECIAL DESIGNATIONS

The North Carolina Natural Heritage Program has designated most of the refuge, with the exception of cropland, moist-soil areas, and the shop area, as a Significant Natural Heritage Area. The Nature Conservancy ranks certain vegetative communities as imperiled or rare (Table 2).

The North Carolina Division of Water Quality has designated several water bodies in the vicinity of Mackay Island Refuge as outstanding resource waters or high-quality waters (Table 5).

The North Carolina Division of Marine Fisheries has designated several streams and water bodies around the refuge as anadromous fish spawning habitats.

## ECOSYSTEM CONTEXT

*OVERVIEW*

Mackay Island National Wildlife Refuge lies within a physiographic region known as the South Atlantic Coastal Plain (Figure 2). The South Atlantic Coastal Plain was once a 25-million-hectare complex of forested wetlands and uplands, dunes, and marshes that extended from Florida to North Carolina. Historically, the extent and duration of seasonal flooding, along the ecosystem's rivers, fluctuated annually, recharging the South Atlantic Coastal Plain's aquatic systems and creating a rich diversity of dynamic habitats, which supported a vast array of fish and wildlife resources.

**Table 2. The Nature Conservancy's ranking of vegetative communities of Mackay Island National Wildlife Refuge**

| Vegetative Community | State Rank | Global Rank |
|---|---|---|
| **Estuarine Fringe Loblolly Pine Forest** | S3 | G3 |
| **Tidal Freshwater Marsh** | S3 | G4 |
| **Mesic Pine Flatwoods** | S3 | G5 |

*S1 = Critically imperiled in North Carolina because of extreme rarity or otherwise very vulnerable to extirpation in the state.*
*S2 = Imperiled in North Carolina because of rarity or otherwise very vulnerable to extirpation in the state.*
*S3 = Rare or uncommon in North Carolina.*
*G1 = Critically imperiled globally because of extreme rarity or otherwise very vulnerable to extinction throughout its range.*
*G2 = Imperiled globally because of rarity or otherwise very vulnerable to extinction throughout its range.*
*G3 = Either very rare or local throughout its range, or found locally in a restricted area.*

## REGIONAL CONSERVATION PLANS AND INITIATIVES

Along with the Service's legal mandates and initiatives, other planning activities directly influence the development of the comprehensive conservation plan. Various groups and agencies develop and coordinate planning initiatives involving regional, state, and local agencies; local communities; non-governmental organizations; and private individuals to help restore habitats for fish and wildlife on and off public lands.

The Service is initiating cooperative partnerships in an effort to reduce the declining trend in biological diversity. Biological planning for species groups targeted in this plan reflect the North American Waterfowl Management Plan, which includes the Atlantic Coast Joint Venture, the Joint Venture between North Carolina Wildlife Resources Commission and Fish and Wildlife Service, Partners-in-Flight Plan, and the South Atlantic Migratory Bird Initiative.

The Atlantic Coast Joint Venture focus is that of the middle- and upper-Atlantic coast. Within the Atlantic Coast Joint Venture was the joint venture formed between the North Carolina Wildlife Resources Commission, Fish and Wildlife Service, and private conservation organizations.

The South Atlantic Coastal Plain serves as a primary migration habitat for migratory songbirds returning from Central and South America. It also provides wintering, breeding, and migration habitat for mid-continental wood duck and colonial bird populations. Restoration of migratory songbird populations is a high priority of the Partners-in-Flight Plan for the South Atlantic Physiographic Region.

**Figure 2. Mackay Island National Wildlife Refuge in the South Atlantic Coastal Plain Physiographic Area.**

The Partners-in-Flight Plan emphasizes land bird species as a priority for conservation. Habitat loss, population trends, and the vulnerability of species and habitats to threats are all factors used in the priority ranking of species. Further, biologists from local offices of the Service, the North Carolina Wildlife Resources Commission, conservation organizations, such as Audubon Society and The Nature Conservancy, have identified focal species for each habitat type from which they will determine population and habitat objectives and conservation actions. This list of focal species, objectives, and conservation actions will aid migratory bird management on the refuge.

The Farm Bill Programs administered by the U.S. Department of Agriculture each have state level plans and priority ranking systems in which the Service has input. The Service also utilizes those programs to assist private landowners in the vicinity of national wildlife refuges to manage habitat for wildlife or protect their land with easements.

The North Carolina Wildlife Resources Commission has its own Comprehensive Wildlife Conservation Strategy to help direct the state's allocation of funds from the federally funded State Working Grants Program. The Service has provided input to the development and execution of the strategy.

## THREATS AND PROBLEMS

### *FOREST AND FRAGMENTATION*

The South Atlantic Coastal Plain has changed markedly over the last 100 years as civilization spread throughout the area. It has been estimated that 40 percent of the natural vegetation has been lost to land conversion. The greatest changes to the landscape have been in the form of land clearing for agriculture and urban development (Hunter et al., 2001).

Although these changes have allowed people to settle and earn a living in the area, they have had a tremendous effect on biological diversity, biological integrity, and environmental health of the South Atlantic Coastal Plain. Development has reduced vast areas of bottomland hardwood forests to forest fragments ranging in size from very small tracts of limited functional value to a few large areas that have maintained many or the original functions and values of forested values. Severe fragmentation has resulted in a substantial decline in biological diversity and integrity. Animal species endemic to the South Atlantic Coastal Plain that have become threatened, endangered, or extinct include the red wolf and red-cockaded woodpecker (Table 3).

Breeding bird surveys show continuing declines in species and species populations. The avian species most adversely affected by fragmentation include those that are area-sensitive (dependent on large continuous blocks of hardwood forest); those that depend on forest interiors; those that depend on special habitat requirements, such as mature forests or a particular food source; and/or those that depend on good water quality. Increased nest parasitism is also common in fragmented forests.

More that 300 species of breeding migratory songbirds are found in the region. Some of these species, including Swainson's warbler, prothonotary warbler, swallow-tailed kites, wood thrush, and cerulean warbler, have declined substantially and need the benefits of large forested blocks to recover and sustain their existence.

Fragmentation has also brought the forest edge and brown-headed cowbird (a seed-eating bird common in agricultural areas) closer to the natural nesting sites of many forest interior-nesting birds. The brown-headed cowbird is a parasitic nester that lays eggs in the nests of other birds, rather than building a nest of its own. Nestling cowbirds are typically bigger and more aggressive and out-compete the young of the species building the nest. This results in poor reproductive success and

declining populations of forest interior-nesting species that are forced to nest near forest edges.

**Table 3. Federally threatened and endangered animal species that occur on the South Atlantic Coastal Plain in North Carolina and Virginia**

| Status | Common Name | Scientific Name |
|---|---|---|
| Endangered | Manatee, West Indian | *Trichechus manatus* |
| Endangered | Sea Turtle, Hawksbill | *Eretmochelys imbricata* |
| Endangered | Sea Turtle, Kemp's Ridley | *Lepidochelys kempii* |
| Endangered | Sea Turtle, Leatherback | *Dermochelys coriacea* |
| Endangered | Stork, Wood | *Mycteria americana* |
| Endangered | Sturgeon, Shortnose | *Acipenser brevirostrum* |
| Endangered | Tern, Roseate | *Sterna dougallii* |
| Endangered | Whale, Finback | *Balaenoptera physalus* |
| Endangered | Whale, Humpback | *Megaptera novaeangliae* |
| Endangered | Whale, Right | *Balaena glacialis* |
| Endangered | Whale, Sea | *Balaenoptera borealis* |
| Endangered | Whale, Sperm | *Physeter catodon* |
| Endangered | Wolf, Red | *Canis rufus* |
| Endangered | Woodpecker, Red-cockaded | *Picoides borealis* |
| Threatened | Alligator, American | *Alligator mississippiensis* |
| Threatened | Eagle, Bald | *Haliaeetus leucocephalus* |
| Threatened | Plover, Piping | *Charadrius melodus* |
| Threatened | Sea Turtle, Green | *Chelonia mydas* |
| Threatened | Sea Turtle, Loggerhead | *Caretta caretta* |
| Threatened | Silverside, Waccamaw | *Menidia extensa* |

Fragmentation of bottomland hardwood forests has left many of the remaining forested tracts surrounded by a sea of agricultural lands. Intensive agriculture has removed most of the forested corridors along sloughs that formerly connected the forest patches. The loss of connectivity between the remaining forested tracts hinders the movement of wildlife between tracts and reduces the functional values of many remaining smaller forest tracts. The lost connections also result in a loss of gene flow. Restoring the connections to allow gene flow and reestablish travel corridors is particularly important for some wide-ranging species such as the black bear.

*ALTERATIONS TO HYDROLOGY*

In addition to the loss of vast acreage of bottomland forested wetlands, there have been substantial alterations in the region's hydrology due to managed stream flows from flood control and hydroelectric power generation reservoirs, drainage ditches, river channel modification, flood control levees, deforestation, and degradation to aquatic systems from excessive sedimentation and contaminants, and urban development.

The natural hydrology of a region is directly responsible for the connectedness of forested wetlands and indirectly responsible for the complexity and diversity of habitats through its effects on topography and soils. Natural resource managers recognize the importance of dynamic hydrology to forested wetlands and waterfowl-habitat relationships (Fredrickson and Heitmeyer 1988).

Instead of natural hydrology, large-scale man-made hydrological alterations have changed the spatial and temporal patterns of flooding throughout the entire South Atlantic Coastal Plain. In addition, these alterations have modified both the extent and duration of annual seasonal flooding. The alteration of this annual flooding regime has had a tremendous effect on the forested wetlands and their associated wetland-dependent species. Specifically, the combination of managed stream flows and drainage ditches in bottomland forests exposes the forests to more frequent flooding than occurs naturally, drains back swamps through natural levees, and floods the back swamps at low flows through the ditches.

In view of the hydrologic changes, it is very difficult, if not impossible, to fully emulate and reconstruct the structure and functions of a natural wetland. According to Mitsch and Gosselink (1993), restoration of wetland functions is especially difficult since wetlands depend on a dynamic interface of hydrologic regimes to maintain water, vegetation, and animal complexes and processes.

*SILTATION OF AQUATIC ECOSYSTEMS*

Siltation from deforestation and hydrologic alteration has degraded aquatic systems, including lakes, rivers, sloughs, and bayous. Clearing of bottomland hardwood forests has led to an accelerated accumulation of sediments and contaminants in all aquatic systems. Sediment now fills many water bodies, greatly reducing their surface area and depth. It also reduces light penetration in shallow water and the growth of submerged aquatic vegetation growing in the water. Concurrently, the non-point source runoff of excess nutrients and contaminants is threatening the area's remaining aquatic resources. Six species of federally threatened aquatic organisms and twelve species of federally endangered aquatic species occur in North Carolina and Virginia.

Hydrologic alterations have basically eliminated the geomorphologic processes that created oxbow lakes, sloughs, and river meander scars. Consequently, the protection, conservation, and restoration of these aquatic resources take on an added importance in light of the alterations associated with flood control and navigation.

*PROLIFERATION OF INVASION AQUATIC PLANTS*

Compounding the problems faced by aquatic systems is the growing threat from invasive aquatic vegetation. Static water levels caused by the lack of annual flooding, and reduced water depths resulting from excessive sedimentation have created conditions favorable for the establishment and proliferation of several species of invasive aquatic plants. Additionally, the introduction of exotic (non-native) vegetation capable of aggressive growth is further threatening viability of aquatic systems. These invasive aquatic species threaten the natural aquatic vegetation important to aquatic systems, and choke waterways to a degree that limits biodiversity and often prevents recreational use.

*CONSERVATION PRIORITIES*

The declines in the South Atlantic Coastal Plain's bottomland hardwood forests and their associated fish and wildlife resources have prompted the Service to designate these forest systems as areas of special concern. A collaborative effort involving private, state, and federal conservation partners is now underway to implement a variety of tools to restore the functions and values of wetlands in the South Atlantic Coastal Plain. The goal is to prioritize and manage wetlands to most effectively maintain and possibly restore the biological diversity in the South Atlantic Coastal Plain. Some areas are prioritized as focus areas for reforestation.

Conservation agencies and organizations have initiated several coordinated efforts to set priorities and establish focus areas to overcome the impacts of hydrologic changes and forest fragmentation. A cooperative private-state-federal partnership, known as the North American Waterfowl Management Plan, Atlantic Coast Joint Venture, was established in 1986 to help provide sufficient wintering waterfowl habitat throughout the Atlantic Coastal Plain.

The initial Atlantic Coast Joint Venture effort for waterfowl has expanded to also establish breeding bird objectives for shorebirds, marshbirds, seabirds, wading birds, and neotropical migratory songbirds. The Atlantic Coast Joint Venture is working with the U.S. Shorebird Conservation Working Group to establish step-down objectives for shorebird foraging habitat for the fall migration period throughout the South Atlantic Coastal Plain.

Partners-in-Flight has developed bird conservation plans to focus a number of private, state, and federal restoration programs into specific areas in an effort to provide maximum program benefits for neotropical migratory songbirds. The goal of this collaborative restoration effort is to provide islands or blocks of habitat in an otherwise highly fragmented landscape. The targeted block sizes of forest habitat range from 10,000 to 100,000 acres. Such areas are large enough to support viable populations of various suites of neotropical migratory interior forest-dwelling songbirds. Of course, these areas will also support other species that depend on large forested blocks. The plans are anchored by existing or proposed state wildlife management areas or national wildlife refuges. These public lands serve as centers of biodiversity that are enhanced and supported by the expansion of blocks of habitat, either through public or private management.

One of the biggest challenges to the management and restoration efforts underway in the South Atlantic Coastal Plain, and one that affects refuges in particular, is the need to meet long-term management objectives that address comprehensive ecosystem needs, including those of wintering migratory waterfowl, neotropical migratory birds, shorebirds, large mammals, and other wide-ranging species. Often, management for one species or species group conflicts with the management objectives for another species or species group. The tendency is to pursue short-term priorities that frequently change as scientific knowledge expands and interests in special resources shift. Land managers must exercise caution to prevent the start-up of management and restoration actions that are difficult to reverse and fail to meet the long-term, comprehensive management needs of the ecosystem or a specific area within the ecosystem. An example might be a tendency to totally manage Mackay Island National Wildlife Refuge in an effort to provide habitat for many species of waterfowl that require wetlands with supporting submerged aquatic vegetation. Such an approach may overlook the critical habitat needs of shorebirds that prefer mudflat habitat.

Partners in the Atlantic Coast Joint Venture can only meet their habitat goals through active management of croplands, moist-soil areas, and forested wetlands on both public and private land (Reinecke and Baxter 1996). Biologists must actively manage land (i.e., vegetation manipulation and hydrology restoration) to compensate for the spatial and temporal habitat changes that deforestation

and hydrologic alterations have caused throughout the South Atlantic Coastal Plain. Properly managed, the Mackay Island National Wildlife Refuge will make a substantial contribution to meeting the objectives of the Atlantic Coast Joint Venture. Setting habitat and species objectives from the perspective of the South Atlantic Coastal Plain is advantageous because it looks at the big picture and enables managers to plan and provide habitat for a diversity of species throughout their range.

Although the management of marshes and forests is probably the best solution for restoring the vast forests that commercial timber management have altered, land managers must remember that hydrology (flooding) drives the ecological system in the South Atlantic Coastal Plain. The plant and animal community throughout the South Atlantic Coastal Plain is dependent upon the hydrologic cycle. It is incumbent upon land managers to manage hydrology in an effort to restore the ecological diversity that once characterized the South Atlantic Coastal Plain. Refuges can install impoundments and structures to control and manage water in an effort to mimic historic flood cycles and to meet wildlife habitat objectives.

*CHALLENGES*

In order for Mackay Island National Wildlife Refuge to meet its multiple objectives of national, regional, and local scope - ranging from marsh and forest management to reducing habitat fragmentation to providing for public use, the Service must fund and staff it well above current levels. Securing adequate funding and personnel and then implementing a variety of programs to achieve the best balance of all objectives, through a system of coordinated planning, is the refuge's biggest challenge. In the interim, as the needed funding and personnel become available, the refuge must concentrate on its highest priorities without committing irreversible actions that would preclude future implementation of the desired management programs.

**PHYSICAL RESOURCES**

*CLIMATE*

Since the flow of air over North Carolina is predominantly from west to east, the continental influence is much greater than the ocean or marine influence. Therefore, the area experiences a fairly large variation in temperature from winter to summer.

The Gulf Stream current flows only a short distance off the North Carolina coast. One might think this "river" of warm water would have a profound effect on the climate. Its direct effects are limited by the fact that the prevailing winds in winter are westerly.

Lows usually reform along the coast as "Cape Hatteras lows" and then move north along the coast. Winter's low-pressure storms are usually more intense because of the large north-to-south contrasts.

Winter's storms bring prolonged periods of steady rain and are responsible for most of the winter precipitation. The forms of precipitation in spring begin to change from these steady rains to occasional thunderstorms. The Gulf of Mexico's warm, moist air produces warm, humid weather throughout the summer. Rainfall comes from occasional thunderstorms. Autumn is slightly drier than the other three seasons and is to many people the most pleasant with its many clear, warm days and cool nights with relatively little rain. This weather usually lasts until November.

Occasional hurricanes do have major impacts on Currituck County. The storms usually pass off the coast east of the Mackay Island Refuge, but may bring large quantities of rain to the refuge. Most North Carolina tornadoes occur in the Piedmont and the interior of the coastal plain, which spares Currituck County.

The average annual precipitation is 46 inches, and the average snowfall is 3 inches. The record snowfall was 14.2 inches at Norfolk, Virginia, and 25 inches at Elizabeth City, North Carolina. Snow accumulations of more than 1 inch for more than a day are rare. Rainfall is evenly distributed throughout the year without a pronounced wet or dry season: average monthly rainfall ranges from 2.98 in November to 5.17 in July. Ten months have average precipitation between three and five inches. Of the total annual precipitation, about 25 inches usually falls in April through September. The growing season for most crops falls within this period.

The average relative humidity in mid-afternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 85 percent. The sun shines 65 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the southwest. Average wind speed is highest, 10 miles per hour, in spring. The average daily maximum temperature is 68 degrees F, and the average daily minimum is 51 degrees.

In January, the average temperature is 40 degrees, the average daily minimum temperature is 32 degrees and the average daily maximum is 48 degrees. In July, the average temperature is 79 degrees, the average daily maximum temperature is 87 degrees, and the average daily minimum is 71 degrees.

The average growing season is 247 days long. The average last date of frost in the spring is March 20 and the first frost in the fall is November 23.

*GEOLOGY*

The Coastal Plain Province lies east of the Piedmont Province. The Piedmont begins at the "Fall Line," which is a broad transition zone where the crystalline rocks of the Piedmont (i.e., the igneous and metamorphic rocks that cause the rapids in the Roanoke River at Roanoke Rapids) become buried by the marine sediments of the Coastal Plain.

Thin beds of Quaternary sediments were deposited on the surface of the Coastal Plain during the past three million years (Riggs and Belknap 1988). This Quaternary history and the resulting surface veneer of unconsolidated sediments directly dictates the general characteristics of the Coastal Plain, including the regional morphology and character of the drainage systems and flooded estuaries, soil types, and potential land use. Quaternary sediments were deposited by the coastal system, which rapidly migrated back and forth across the Coastal Plain-Continental Shelf as sea-level fluctuated in response to repeated episodes of glaciation and deglaciation. Within this rapidly changing coastal system, extremely varied sediments, including gravel, sands, clays, and peat in all possible combinations, were deposited in river, estuarine, barrier island, and continental shelf environments. The Quaternary sediments range from a few meters in thickness in places along the lower Roanoke River up to 70 meters in the outer Albemarle area (Riggs, et al., in prep.). The Quaternary history continues today.

*MINERALS*

Sand is the only mineral resource occurring in economic quantities. There is a commercial sand pit adjacent to the refuge's northern boundary in Virginia Beach, Virginia.

*SOILS*

Soil types identified on the refuge are Altavista fine sandy loam, Augusta fine sandy loam, Bojac loamy sand, Conetoe loamy fine sand, Currituck mucky peat*, Dragston loamy fine sand, Munden loamy sand, Nimmo loamy sand*, Roanoke fine sandy loam*, State fine sandy loam, and Wahee fine sandy loam* (USDA, Soil Conservation Service 1982). Soils with an asterisk are listed as hydric in

'Hydric Soils of the United States' (USDA, Soil Conservation Service 1985) (Figure 3) (Table 4). Hydric soils are . . . "soils that in their undrained condition are saturated, flooded or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic (water loving) vegetation" (USDA, Soil Conservation Service 1985).

Most of the refuge is Currituck mucky peat, an organic soil with 60 inches of mucky peat and muck over sand. It floods regularly with tidal fluctuations and has a water table from the surface to one foot below the surface. Currituck soils support freshwater and brackish herbaceous marsh vegetation.

Roanoke fine sandy loam, Wahee fine sandy loam, and Nimmo loamy sand are poorly drained soils that occur on the outer perimeter of the Currituck soils. Roanoke soils have eight inches of fine sandy loam soil over silty clay loam and silty clay subsoil with slow permeability. They have water tables from the surface to one foot below the surface. They flood more than once every two years, but only for two to seven days. Roanoke soils support hardwood forest vegetation adapted to poor drainage. Wahee soils have seven inches of fine sandy loam soil over clay loam and clay with slow permeability. They have water tables from six to eighteen inches below the surface, but do not flood. Wahee soils support pine and hardwood forest vegetation adapted to poor drainage. Nimmo soils have nine inches of fine loamy sand soil over sandy loam and sand with moderate permeability. They have water tables from zero to six inches below the surface, but do not flood. Nimmo soils support pine and hardwood forest vegetation adapted to poor drainage.

Bojac loamy sand, State fine sandy loam, and Conetoe loamy fine sand are well-drained soils that occur on the eastern and western edges of the refuge. Bojac loamy sand has 72 inches of loamy sand over sandy subsoil. The water table is more than four feet below the surface. Bojac soils also support hardwood and pine forests adapted to good drainage. They are also excellent soils for cropland and building construction. State fine sandy loam has 43 inches of fine sandy loam over loamy sand subsoil. The water table is four to six feet below the surface. State soils support hardwood and pine forests adapted to good drainage. They are also excellent soils for cropland and building construction. Conetoe fine sandy loam has eight inches of loamy fine sand over loamy sand, clay loam, and sandy subsoil. The water table is more than four feet below the surface. Conetoe soils support hardwood and pine forests adapted to good drainage. They are also excellent soils for cropland and building construction.

Altavista fine sandy loam, Dragston loamy fine sand, Augusta fine sandy loam, and Munden loamy sand 1.5-2.5 are moderately well-drained soils and somewhat poorly drained that occur on the eastern and western edges of the refuge. Altavista fine sandy loam has nine inches of fine sandy loam over sandy clay loam subsoil. The water table is one to two feet below the surface. Altavista soils also support hardwood and pine forests adapted to moderately good drainage. Dragston loamy fine sand has eight inches of loamy fine sand over sandy loam subsoil. The water table is twelve to thirty inches below the surface. Dragston soils support hardwood and pine forests adapted to somewhat poor drainage. Augusta fine sandy loam has eight inches of fine sandy loam over clay loam subsoil. The water table is one to two feet below the surface. Augusta soils support hardwood and pine forest adapted to somewhat poor drainage. Munden loamy sand has nine inches of fine loamy sand over sandy loam subsoil. The water table is eighteen to thirty inches below the surface. Munden soils support hardwood and pine forests adapted to moderately good drainage.

**Table 4. Characteristics of Soils of Mackay Island National Wildlife Refuge**

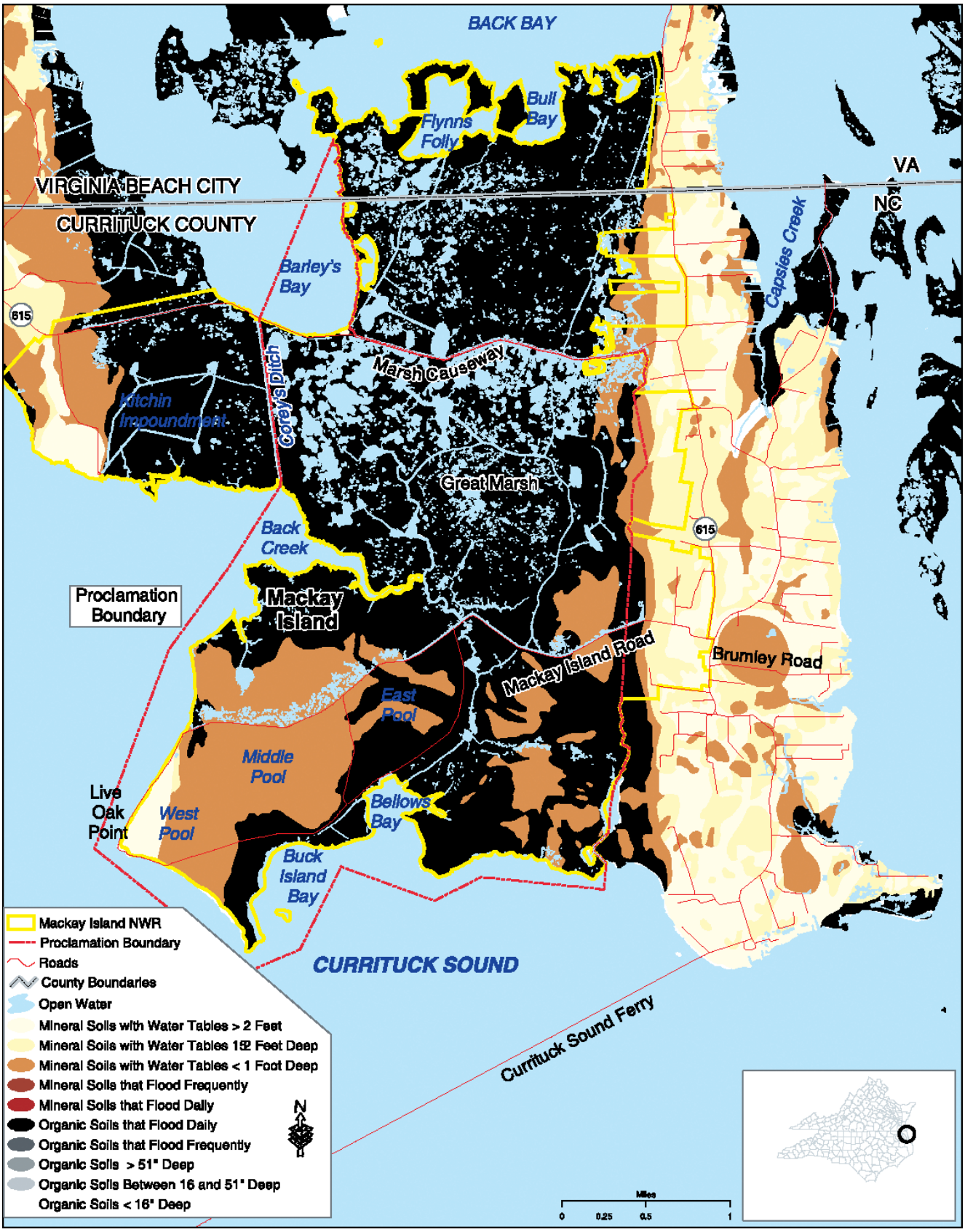
| Series | Approximate Acreage | Surface Texture | Muck Depth | Water Table Depth | Flooding Frequency |
|---|---|---|---|---|---|
| **Currituck** | 4,800 | Mucky Peat | 60’ | 0-1’ | Regular |
| **Roanoke** | 1,311 | Loam | None | 0-1’ | Frequent |
| **Bojac** | 110 | Loamy Sand | None | >4’ | Never |
| **Altavista** | 100 | Fine Sandy Loam | None | 1-2’ | Never |
| **Dragston** | 88 | Loamy Fine Sand | None | 1.0-2.5 | Never |
| **State** | 70 | Loamy Fine Sand | None | 4-6’ | Never |
| **Nimmo** | 65 | Loamy Sand | None | 0.0-0.5 | Never |
| **Conetoe** | 50 | Loamy Fine Sand | None | >6’ | Never |
| **Augusta** | 45 | Fine Sandy Loam | None | 1-2’ | Never |
| **Wahee** | 10 | Fine Sandy Loam | None | 0.5-1.5 | Never |
| **Munden** | 5 | Loamy Sand | None | 1.5-2.5 | Never |
| **Total Land** | 6,664 | | | | |
| **Water** | 681 | | | | |
| **Total** | **7,345** | | | | |

*HYDROLOGY*

The refuge is 77 percent hydric soil that is maintained as natural or managed wetlands. Fifty-five percent of the refuge is subject to regular inundation by tidal waters. These wetlands are in the coastal plain province. Water is the driving force of the Mackay Island Refuge's marsh and hardwood/pine forest communities. Water forms and maintains the wetlands by transporting and redistributing sediments from watersheds upstream. It provides seasonal access for aquatic organisms to the marsh and forest and transports nutrients and detritus across the marsh. Sources of water to the area’s hydrologic system include precipitation and runoff and groundwater that originate from it.

Groundwater is the source of the county’s water supply. The depth to freshwater is generally less than 100 feet. The freshwater is contained in sands and clays of the upper sandy aquifer, which is capable of yielding up to 50 gallons per minute. The maximum available groundwater is estimated at one million gallons per day per square mile. The water from deeper wells in the freshwater zone tends to be hard and may contain excessive iron. Water from shallow wells may be hard or soft and may also contain excessive iron (T.M. Robison 1977).

**Figure 3. Hydric and non-hydric soil of Mackay Island National Wildlife Refuge.**



Water Quality

The water quality on Mackay Island National Wildlife Refuge is related directly to the water quality in Currituck Sound. Impoundment waters are maintained through exchange with Currituck Sound. Nutrient loading in the North Landing and northwest rivers and related non-point source pollution will affect the water quality of the refuge in the future.

Developments and agricultural operations in the area located on hydric soils, non-hydric soils with high water tables, or soils with rapid permeability all have the potential to pollute the water table with septic system percolate, household wastes, and nutrients, pesticides, and petroleum products. Recreational use of the streams and water bodies may also impact water quality.

There are no facilities on Knotts Island, North Carolina, in the National Pollution Discharge Elimination System. There are numerous facilities in Virginia watersheds that drain into the water bodies around the Mackay Island National Wildlife Refuge.

The State of North Carolina and Commonwealth of Virginia have classified the water bodies around Mackay Island National Wildlife Refuge for minimum water quality standards (Table 5). All water bodies and streams meet the standards established for the best uses.

**Table 5. Classifications of water bodies and streams surrounding the Mackay Island National Wildlife Refuge**

| Water Body or Stream | Classification | Best Uses |
|---|---|---|
| Back Bay (VA)<br>North Landing River (VA)<br>Northwest River (VA) | VA Class II | Secondary Recreation, Fishing, Aquatic Life |
| Currituck Sound (NC)<br>Knotts Island Bay (NC)<br>Knotts Island Channel (NC)<br>Capsies Creek (NC)<br>Porpoise Slough (NC)<br>North Landing River (NC) | SC – Saltwater | Secondary Recreation, Fishing, Aquatic Life |
| Gibbs Creek (NC)<br>Northwest River (NC)<br>Moyock Run (NC)<br>Peter Dozier Pond (NC)<br>Buck Island Pond (NC)<br>Nellie Bell Ponds (NC) | C – Freshwater<br>Sw – Swamp Waters | Secondary Recreation, Fishing, Aquatic Life |

*AIR QUALITY*

In North Carolina, state law states that no source of air pollution shall cause any listed ambient air quality standard (Section .0400) to be exceeded or contribute to a violation of any listed ambient air quality standard (Section .0400) except as allowed by Rules .0531 or .0532 [.0401(c), NCAC, Title 15A, Subchapter 2D - Air Pollution Control Requirements (North Carolina Department of Environment and Natural Resources)].

Subchapter 2D lists ambient air quality standards for sulfur oxides (measured as sulfur dioxide), total suspended particulates, carbon monoxide, ozone, hydrocarbons, nitrogen dioxide, lead, and particulate matter. Section .0508 enumerates control of particulates from pulp and paper mills.

Section 0.0520 (7) indicates that fires purposely set to forest lands for forest management practices acceptable to the North Carolina Division of Forestry and the Environmental Management Commission are permissible if not prohibited by ordinances and regulations of governmental entities having jurisdiction. The regulation also includes a disclaimer that addresses certain potential liabilities of burning even though permissible.

The area closest to the refuge that an environmental agency monitors is the Virginia Beach-Norfolk metropolitan area. The Environmental Protection Agency monitors carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide and particulates in Norfolk, Virginia Beach, Hampton, Newport News, Suffolk, and Chesapeake. Despite the large population with the industry, traffic, and power plants, the area has exceeded only ozone level standards in 2002. Monitoring has indicated unhealthy levels twice and unhealthy levels for sensitive groups thirteen times. The air quality is due to the breezes blowing through the area from the ocean.

*VISUAL RESOURCES*

The Mackay Island Refuge is part of an extensive complex of brackish marshes along the North Landing River, Back Bay, Knotts Island Bay, and Currituck Sound. The marshes are largely undisturbed protected by the Federal Government at the Mackay Island, Currituck, and Back Bay National Wildlife Refuges; by the State of North Carolina at the 2,958-acre Northwest Marsh Game Land and the 14,657-acre North River Game Land; by the Commonwealth of Virginia at the 1,546-acre Princess Ann Wildlife Management Area, the 4,321-acre False Cape State Park, the 3,441-acre North Landing River Natural Area Preserve, and the 2,417-acre Northwest River Natural Area Preserve; by the City of Virginia Beach at the North Landing Park and by The Nature Conservancy. Visitors to the refuge have the opportunity to experience solitude, wildness, uninterrupted quiet, spirit and adventure, and observe the signs and the sounds of activity in the marsh and forested wetlands. The casual observer will see large expanses of brackish marsh and hardwood/pine forest. During the growing season, the marshes appear alive with neotropical songbirds, raptors, wading birds, marsh birds, mink, otter, and other wildlife species. The forests of loblolly pine, red maple, black gum, sweetgum, green ash, and wax myrtle echo the sounds of songbirds, wood ducks, and deer.

**BIOLOGICAL ENVIRONMENT**

*HABITAT*

The Mackay Island National Wildlife Refuge is a typical southeastern United States coastal wetland system that has formed brackish marshes and forested swamps in the Coastal Plain region. There are no plant species from the Federal Endangered Species List known to occur on the refuge. The National Wetlands Inventory described the refuge as an estuarine emergent herbaceous or

palustrine, forested wetland with deciduous or broad-leafed deciduous vegetation and a water regime ranging from temporarily flooded to semipermanently flooded (Cowardin et al., 1979) (Figure 4). Schafale and Weakley (1990) classify the three natural communities within the refuge boundary as: tidal freshwater marsh, estuarine fringe loblolly pine forest, and mesic pine flatwoods. Other habitats have been altered or created by man.

Tidal Freshwater Marsh. Marshes occupy 4,774 acres and tend to occur on the peat soils in the center section of the refuge from Back Bay in the north to the North Landing River in the south. The marshes were brackish when numerous inlets occurred along the Outer Banks; they are now influenced more by freshwater, but still have plants typical of brackish marshes. The Nature Conservancy ranks the marshes as S3, or rare in North Carolina, and G4, or apparently secure globally. They are dominated by black needle rush and saltmeadow cordgrass with big cordgrass, seashore saltgrass, and sawgrass present in substantial quantities. With frequent fires, the black needle rush is suppressed and the other grasses dominate. In the absence of fire, black needle rush dominates the stand. The staff currently burns the marshes on a 3-year rotation to maintain the diversity of vegetation in the marsh and the palatability of that vegetation. The staff does not survey vegetation in the marshes before or after the prescribed burns.

Estuarine Fringe Loblolly Pine Forest. The estuarine fringe loblolly pine forest occurs on 1,329 acres of mineral hydric soils to the east and west of the brackish marsh. The Nature Conservancy ranks the forests as S3, or rare in North Carolina, and G3, or very rare throughout its range. Species in the forest include loblolly pine, red maple, swamp tupelo, sweetgum, green ash, wax myrtle, and saltmeadow cordgrass. With frequent fires, the hardwoods and wax myrtle are suppressed and the pine and cordgrass dominate.

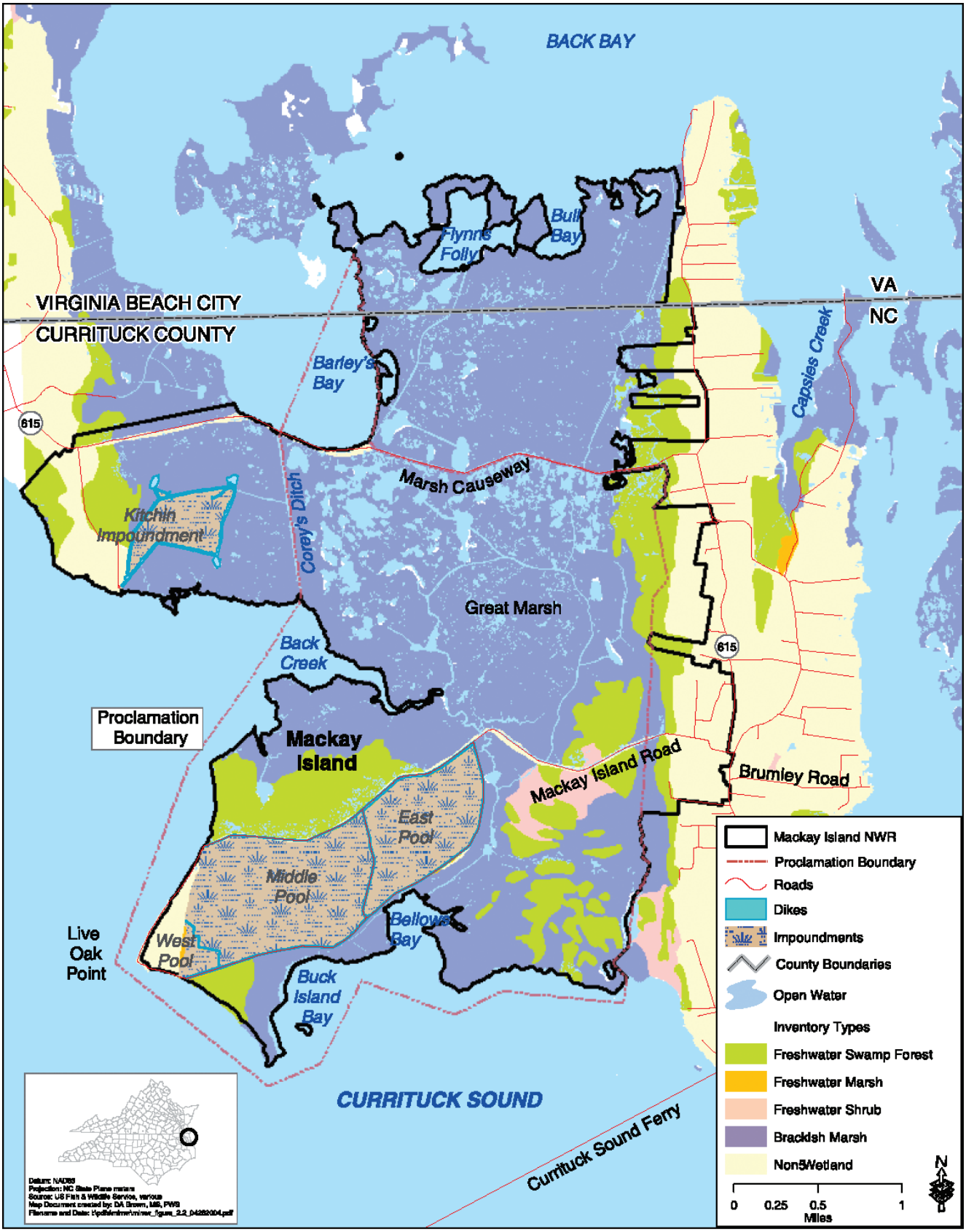
Mesic Pine Flatwoods. The refuge includes 131 acres of this community. It is found on the well-drained ridges near Knotts Island Road. The Nature Conservancy ranks the forests as S3, or rare in North Carolina, and G5, or demonstrably very secure. The typical tree species present are sweetgum, American holly, and loblolly pine. Shrubs include dogwood, ironwood, blueberry, and gallberry and the ground cover consists of mixed grasses and sedges. In certain forest stands on the refuge, the understory is infested with Chinese privet, an exotic invasive shrub. The refuge does not actively manage or regularly survey the forest, but does treat outbreaks of insects and diseases as they occur and conduct prescribed burning when the proper conditions exist.

Cropland. The refuge manages 298 acres of cropland. A cooperative farmer grows corn, wheat, and soybeans on 241acres. The farmer plants 50 acres as wheat pasture for migratory geese and swans. The cooperative farmer is required to follow the Cropland Management Plan and annual Cooperative Farming Agreements to ensure that he produces the crop without damage to the environment.

Firebreaks. The refuge manages 8 (2 miles) acres of firebreaks to provide safe defensible edges from which to manage prescribed fires and wildfires. The staff manages the firebreaks to provide low-growing vegetation that will control erosion and produce forage for wildlife.

Moist-soil Units. The refuge manages 876 acres of impoundments as managed wetlands to produce vegetation that will produce seed to feed waterfowl and to expose mudflats that will serve as habitat for invertebrates to feed shorebirds. Water levels are managed to provide optimum hydrological conditions for the vegetation and the staff mows, burns, and discs the vegetation to maintain a stage of succession that will produce an optimum amount of seed. They survey the vegetation to monitor the effectiveness of their management (Tables 6, 7, and 8).

**Figure 4. Vegetative habitat types of Mackay Island National Wildlife Refuge**



Roads. The refuge manages 220 acres (9.2 miles) of roads and roadsides to provide administrative access and visibility along the roads. The staff manages the road surfaces to provide a safe, durable surface. They maintain the roadsides to provide a low-growing vegetative cover that will control erosion and produce forage for wildlife.

**Table 6. Vegetative composition of the Mackay Island east pool moist-soil unit.**

| Common Name | Scientific Name | Food Value | Percent Composition By Year | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2002 | 1997 | 1989 | 1981 | 1972 |
| **Unidentified Grass** | *NA* | Good | 32.0 | 1.8 | 0.0. | 0.0 | 0.0 |
| **Fleabane** | *Pluchea purascens* | None | 26.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Fall Panicum** | *Panicum dichotomflorm* | Good | 22.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Spikerushes** | *Eleocharis sp* | Good | 8.0 | 0.0 | 0.0 | 27.0 | 36.6 |
| **Water Hysop** | *Bacopa spp.* | Good | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Soft Rush** | *Juncus effusus* | None | 3.0 | 0.5 | 0.0 | 0.0 | 0.0 |
| **Flatsedges** | *Cyperus spp.* | Fair | 3.0 | 2.3 | 0.0 | 0.0 | 0.0 |
| **Baldrush** | *Fimbristylis spp.* | Fair | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Cattail** | *Typha spp.* | None | 1.0 | 0.9 | 1.9 | 0.0 | 0.0 |
| **Three Square** | *Scirpus pungens* | Fair | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Sedges** | *Carex spp.* | Fair | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Millet** | *Echinochloa crusgalli* | Good | 0.2 | 5.4 | 0.0 | 0.0 | 0.0 |
| **Eurasian Milfoil** | *Myriophyllum spicatum* | Good | 0.0 | 61.7 | 22.8 | 0.0 | 0.0 |
| **Bare** | *NA* | None | 0.0 | 16.2 | 28.2 | 6.0 | 1.7 |
| **Smartweed** | *Polygonum sp* | Good | 0.0 | 3.6 | 0.0 | 21.0 | 1.7 |
| **Niad** | *Najas quadalupensis* | Good | 0.0 | 1.8 | 21.8 | 0.0 | 0.0 |
| **Common Reed** | *Phragmites australis* | None | 0.0 | 0.5 | 1.0 | 0.0 | 0.0 |
| **Muskgrass** | *Chara spp.* | Good | 0.0 | 0.0 | 18.9 | 0.0 | 0.0 |
| **Pondweed** | *Potamogeton spp.* | Good | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 |
| **Black Needlerush** | *Juncus roemerianus* | None | 0.0 | 0.0 | 0.0 | 14.0 | 49.1 |
| **Cordgrass** | *Spartina patens* | None | 0.0 | 0.0 | 0.0 | 8.0 | 0.0 |
| **Beggarticks** | *Bidens spp.* | Good | 0.0 | 0.0 | 0.0 | 4.0 | 0.0 |
| **Total Good** | | | **64.8** | **74.3** | **64.0** | **52.0** | **38.3** |
| **Total Fair** | | | **5.4** | **2.3** | **0.0** | **0.0** | **0.0** |
| **Total None** | | | **29.8** | **18.1** | **31.1** | **28.0** | **50.8** |
| **Grand Total** | | | **100.0** | **94.7** | **95.1** | **80.0** | **89.1** |

**Table 7. Vegetative composition of the Mackay Island middle pool moist-soil unit.**

| Common Name | Scientific Name | Food Value | Percent Composition By Year | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2002 | 1999 | 1996 | 1994 | 1989 |
| **Niad** | *Najas quadalupensis* | Good | 48.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Soft Rush** | *Juncus effusus* | None | 16.0 | 1.1 | 5.8 | 4.9 | 16.7 |
| **Bare** | *NA* | None | 15.0 | 3.8 | 1.1 | 40.0 | 46.5 |
| **Foursquare** | *Eleocharis quadrangulata* | Good | 15.0 | 3.0 | 0.0 | 0.6 | 0.0 |
| **Fleabane** | *Pluchea purascens* | None | 7.0 | 6.7 | 0.0 | 0.0 | 0.0 |
| **Cordgrass** | *Spartina patens* | None | 2.0 | 0.0 | 0.0 | 2.4 | 0.0 |
| **Common Reed** | *Phragmites australis* | None | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Eurasian Milfoil** | *Myriophyllum spicatum* | Good | 1.0 | 0.2 | 0.0 | 0.0 | 0.0 |
| **Asian Pennywort** | *Centella asiatica* | Fair | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Alligatorweed** | *Alternanthera philoxeroides* | None | 0.2 | 0.0 | 0.0 | 0.7 | 0.0 |
| **Fall Panicum** | *Panicum dichotomflorm* | Good | 0.2 | 7.7 | 45.7 | 0.1 | 0.0 |
| **Millet** | *Echinochloa crusgalli* | Good | 0.0 | 48.0 | 7.3 | 0.0 | 0.0 |
| **Pondweed** | *Potamogeton spp.* | Good | 0.0 | 11.1 | 0.0 | 0.0 | 0.0 |
| **Flatsedges** | *Cyperus spp.* | Fair | 0.0 | 6.7 | 31.0 | 0.0 | 11.4 |
| **Frogbit** | *Limnobium spongia* | Fair | 0.0 | 5.0 | 0.0 | 2.3 | 0.0 |
| **Sloughgrass** | *Sacciolepsis striata* | Good | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 |
| **Dogfennel** | *Eupatorium capillifolium* | None | 0.0 | 1.0 | 0.6 | 0.0 | 0.4 |
| **Spikerushes** | *Eleocharis spp.* | Good | 0.0 | 0.6 | 0.6 | 0.0 | 15.4 |
| **Knotgrass** | *Paspalum distichum* | Fair | 0.0 | 0.6 | 0.4 | 2.3 | 0.0 |
| **Bladderwort** | *Utricularia spp.* | Good | 0.0 | 0.0 | 0.0 | 42.7 | 0.0 |
| **Total Good** | | | **63.4** | **72.5** | **53.0** | **44.7** | **15.4** |
| **Total Fair** | | | **0.3** | **12.3** | **31.4** | **4.6** | **11.4** |
| **Total None** | | | **36.3** | **12.6** | **7.5** | **48.0** | **63.6** |
| **Grand Total** | | | **100.0** | **97.4** | **91.9** | **96.3** | **90.4** |

**Table 8. Vegetative composition of the Mackay Island west pool moist-soil unit.**

| Common Name | Scientific Name | Food Value | Percent Composition By Year | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2002 | 1999 | 1996 | 1994 | 1979 |
| **Water Hysop** | *Bacopa spp.* | Good | 32.2 | 3.3 | 6.2 | 0.0 | 5.7 |
| **Millet** | *Echinochloa crusgalli* | Good | 23.9 | 2.0 | 4.6 | 0.0 | 20.5 |
| **Fleabane** | *Pluchea purascens* | None | 19.9 | 27.0 | 4.4 | 0.0 | 2.3 |
| **Fall Panicum** | *Panicum dichotomflorm* | Good | 5.8 | 53.1 | 21.9 | 0.0 | 14.1 |
| **Baldrush** | *Fimbristylis spp.* | Fair | 5.4 | 0.0 | 0.3 | 0.0 | 20.9 |
| **Knotgrass** | *Paspalum distichum* | Fair | 5.0 | 1.5 | 4.0 | 0.0 | 0.0 |
| **Crabgrass** | *Digitaria spp.* | Good | 3.0 | 0.0 | 0.0 | 0.0 | 1.5 |
| **Flatsedges** | *Cyperus spp.* | Fair | 2.4 | 4.2 | 2.5 | 0.0 | 11.8 |
| **Alligatorweed** | *Alternanthera philoxeroides* | None | 1.7 | 0.0 | 4.5 | 44.0 | 0.0 |
| **Dogfennel** | *Eupatorium capillifolium* | None | 0.0 | 3.5 | 0.0 | 0.0 | 0.0 |
| **Aster** | *Aster spp.* | Good | 0.0 | 1.8 | 0.1 | 0.0 | 0.0 |
| **Foxtail** | *Setaria spp.* | Good | 0.0 | 1.3 | 0.5 | 0.0 | 0.8 |
| **Bare** | *NA* | None | 0.0 | 0.4 | 23.0 | 32.0 | 1.1 |
| **Frogfruit** | *Lippia lanceolata* | Good | 0.0 | 0.4 | 0.1 | 3.0 | 2.7 |
| **Spikerushes** | *Eleocharis spp.* | Good | 0.0 | 0.4 | 0.0 | 3.0 | 6.5 |
| **Bermudagrass** | *Cynodon dactylon* | None | 0.0 | 0.0 | 24.2 | 6.0 | 0.0 |
| **Asian Pennywort** | *Centella asiatica* | Fair | 0.0 | 0.0 | 1.4 | 0.0 | 0.0 |
| **Paspalum** | *Paspalum spp.* | Fair | 0.0 | 0.0 | 0.3 | 4.0 | 0.0 |
| **Smartweed** | *Polygonum spp.* | Good | 0.0 | 0.0 | 0.2 | 0.0 | 5.3 |
| **Beggarticks** | *Bidens spp.* | Good | 0.0 | 0.0 | 0.1 | 0.0 | 1.9 |
| **Total Good** | | | **82.3** | **62.3** | **33.1** | **6.0** | **59.0** |
| **Total Fair** | | | **15.8** | **5.7** | **8.5** | **4.0** | **32.7** |
| **Total None** | | | **21.7** | **31.9** | **56.1** | **82.0** | **3.4** |
| **Grand Total** | | | **100.o** | **99.9** | **97.7** | **92.0** | **95.1** |

*WILDLIFE*

**Birds**. The threatened bald eagle has nested on the refuge for the past seven years. The Fish and Wildlife Service and/or the State of North Carolina and/or the Commonwealth of Virginia list several refuge species as high priority or rare and of special concern. These include the prairie warbler, hooded warbler, black-throated green warbler, yellow-throated warbler, prothonotary warbler, northern parula, sharp-tailed sparrow, northern bobwhite, king rail, black rail, solitary sandpiper, semipalmated sandpiper, black tern, American black duck, American woodcock, short-eared owl, and American kestrel to name a few. Biologists have seen the endangered red-cockaded woodpecker on rare occasion, with the most recent sighting more than 20 years ago. At least 187 species of birds, including 60 breeding species, utilize the refuge (Appendix V!).

Wintering and migrating waterfowl make extensive use of the Refuge's wetlands. Principle species include the snow goose, tundra swan, mallard, wood duck, American black duck, and American widgeon, green-winged teal, gadwall, and northern pintail (Tables 9, 10, and 11). The marshes surrounding Currituck Sound, Back Bay, and Knotts Island Bay provide habitat for a substantial portion of the most commonly harvested duck species in North Carolina.

Recent studies (U.S. Fish and Wildlife Service 1983) have shown the importance of wooded wetlands to wintering waterfowl as prime sources of cover and food, providing supplemental dietary needs prior to spring migration, mating, and nesting. Migratory mallards, American black ducks, and some wood ducks utilize coastal fringe evergreen forests primarily in the fall and winter months. They often feed on the vegetable matter found in shallow water, and for migration and pre-breeding activities they supplement this with the high protein foods found in the wooded wetlands, including acorns; beechnuts; the seeds of buttonbush; bald cypress and tupelo gums; insects; and the abundant floodplain aquatic invertebrates, such as snails, crustaceans, and insects (Bellrose 1976). Other wood ducks move into the area in the late winter and spring to nest in cavities in the standing timber in the coastal fringe evergreen forests.

**Mammals**. The combination of hard and soft mast producing trees, the availability of cover habitat, and nearby cropland provides forage for large white-tailed deer populations. Furbearers present include raccoon, mink, muskrat, otter, fox, bobcat, and opossum (Barick and Critcher 1975). Nutria are exotic pests that burrow into impoundment dikes and consume marsh grasses.

**Reptiles and Amphibians**. The Service has not performed a comprehensive survey of reptiles and amphibians at the Mackay Island Refuge. The refuge staff adapted the list of reptiles and amphibians in Appendix IV from the Environmental Impact Statement prepared for the Currituck National Wildlife Refuge in 1980.

**Fish**. The Service has not performed a comprehensive survey of fish at Mackay Island Refuge. The refuge staff adapted the list of fish in Appendix IV from the Environmental Impact Statement prepared for the Currituck National Wildlife Refuge in 1980.

**Invertebrates**. The Service has not performed a comprehensive survey of invertebrates at Mackay Island Refuge. The list of invertebrates in Appendix IV is from the Environmental Impact Statement prepared for the Currituck National Wildlife Refuge in 1980.

**Table 9. Mackay Island National Wildlife Refuge waterfowl survey results, 2002-2003.**

| Species | October | November | December | January | February |
|---|---|---|---|---|---|
| **American Black Duck** | 396 | 1,923 | 1,275 | 535 | 569 |
| **Gadwall** | 125 | 972 | 1,151 | 682 | 492 |
| **Mallard** | 207 | 526 | 728 | 800 | 391 |
| **Green-winged Teal** | 474 | 595 | 204 | 155 | 230 |
| **Common Merganser** | 0 | 0 | 0 | 0 | 1,000 |
| **American Widgeon** | 0 | 204 | 0 | 445 | 0 |
| **Northern Pintail** | 56 | 103 | 40 | 54 | 290 |
| **Ruddy Duck** | 0 | 350 | 0 | 0 | 0 |
| **American Coot** | 0 | 50 | 100 | 0 | 0 |
| **Greater Scaup** | 100 | 6 | 0 | 0 | 40 |
| **Northern Shoveler** | 0 | 0 | 0 | 85 | 2 |
| **Ring-necked Duck** | 0 | 0 | 0 | 0 | 11 |
| **Hooded Merganser** | 0 | 2 | 5 | 0 | 0 |
| **Blue-winged Teal** | 0 | 2 | 0 | 0 | 0 |
| **Snow Goose** | 3 | 7,000 | | 1,500 | 5,000 |
| **Tundra Swan** | | 18 | 765 | 625 | 722 |
| **Canada Goose** | 100 | 400 | 270 | 160 | 131 |
| **Total Ducks** | **1,358** | **4,683** | **3,403** | **3,756** | **2,177** |
| **Grand Total** | **1,461** | **12,151** | **4,538** | **6,041** | **7,363** |

**Table 10. Mackay Island National Wildlife Refuge shorebird/wading bird survey results, spring 2003.**

| Species | April 18 | May 8 | May 27 |
|---|---|---|---|
| **Snowy Egret** | 40 | 41 | 36 |
| **Yellowlegs** | 50 | 25 | 1 |
| **Semipalmated Sandpiper** | | 45 | 29 |
| **Great Egret** | 36 | 15 | 16 |
| **Glossy Ibis** | | 2 | 40 |
| **Great Blue Heron** | 18 | 5 | 3 |
| **Little Blue Heron** | 13 | | 7 |
| **Dunlin** | | 6 | 1 |
| **Least Sandpiper** | | 7 | |
| **White Ibis** | 5 | | |
| **Semipalmated Plover** | | | 4 |
| **Spotted Sandpiper** | | 2 | |
| **Solitary Sandpiper** | | 2 | |
| **Total** | **167** | **151** | **137** |

**Table 11. Mackay Island National Wildlife Refuge shorebird/wading bird survey results, fall 2002.**

| Species | July 5 | July 25 | August 5 | August 28 | September 16 | September 25 |
|---|---|---|---|---|---|---|
| **Great Egret** | 21 | 45 | 33 | 36 | 17 | 8 |
| **Great Blue Heron** | 5 | 6 | 9 | 9 | 4 | 5 |
| **Common Snipe** | | | 3 | 1 | 1 | 4 |
| **Killdeer** | 5 | 6 | | | | 2 |
| **Lesser Yellowlegs** | | | | 2 | 2 | 2 |
| **Greater Yellowlegs** | | | | | 3 | 1 |
| **American Bittern** | | | | | | 1 |
| **Glossy Ibis** | | | | | | 1 |
| **Solitary Sandpiper** | | | | | | |
| **Tricolored Heron** | | 7 | 5 | 2 | 2 | |
| **Snowy Egret** | 7 | 7 | 10 | 7 | 4 | |
| **Spotted Sandpiper** | 6 | 3 | 2 | 8 | | |
| **Little Blue Heron** | 7 | 9 | 12 | 4 | | |
| **Western Sandpiper** | | | | 3 | | |
| **Peep** | | 5 | | 33 | | |
| **Least Sandpiper** | | 1 | | 5 | | |
| **Green Heron** | 2 | 4 | | 1 | | |
| **Cattle Egret** | 2 | | | 1 | | |
| **Double-crested Cormorant** | 1 | | 2 | | | |
| **Short-billed Dowitcher** | | 3 | | | | |
| **White Ibis** | | 1 | | | | |
| **Least Bittern** | 4 | | | | | |
| **Belted Kingfisher** | 2 | | | | | |
| **Total** | **62** | **97** | **76** | **112** | **33** | **24** |

*INSECTS AND DISEASES*

In recent years, the forest tent caterpillar has caused widespread defoliation in the state. Prolonged flooding and saturation on coastal plain soils adversely impact the parasitic wasp that preys on the forest tent caterpillar. The parasitic wasp spends part of its life cycle in the ground. Prolonged flooding kills the wasp that can no longer serve as a check on the populations of the forest tent caterpillar. This may account for the large outbreaks resource managers have been observing over the last decade on the coastal plain.

The gypsy moth is now well established as far south as northeastern North Carolina. The North Carolina Division of Plant Industry and United States Forest Service closely monitor gypsy moth populations. They utilize pheromone traps located throughout the state including refuge lands. When they detect large-scale outbreaks, they use integrated pest management techniques to suppress the outbreak, but not necessarily eliminate the species from the area.

Southern pine beetle is becoming a more common pest of pines in northeastern North Carolina. The beetles feed on the inner bark of stress-weakened trees. The needles turn yellow or straw-colored within two or three weeks of the attack, before finally turning reddish-brown. Land managers treat infected stands by cutting down a swath of trees around the area where the beetles are actively feeding, thus removing their food and starving them. Managers must monitor their pine stands and investigate any trees that appear infected.

*EXOTIC ORGANISMS*

There are four exotic animals present within the area and thus are presently impacting or have the potential to impact Refuge lands. They are the Asian clam (*Corbicula fluminea*), common carp (*Cyprinus carpio*), nutria (*Myocaster coypus*) and the gypsy moth (*Lymantria dispar*). Exotic plants that threaten refuge resources include common reed (*Phragmites australis*), alligatorweed (*Alternanthera philoxeroides*), fleabane (*Erigeron annuus*), johnsongrass (*Sorghum halpense*), and Chinese privet (*Ligustrum chinense*).

*THREATENED AND ENDANGERED SPECIES*

After an absence of many years, the threatened bald eagle recently returned to nest on the refuge. There are records of the occurrence of the endangered red-cockaded woodpecker in the county from more than 20 years ago. There have been incidental reports of endangered West Indian manatees in the county, well north of their normal range. No other federally threatened or endangered species are known to occur on or adjacent to refuge lands.

The refuge staff will give the status and habitat requirements of these species primary consideration when planning and implementing management actions. The refuge will also give emphasis to state-listed species.

**CULTURAL RESOURCES**

There is a cemetery and the foundation of the Joseph P. Knapp residence, and thirteen other cemeteries on the refuge. The refuge does not maintain them, but does no intensive management in their vicinity that would damage the graves or their markers. One is on the north side of the entrance road in the northern end on the refuge. A fence surrounds it and private interests maintain the grass cover. The foundation of the Joseph P. Knapp residence is on Live Oak Point in the southeastern part of the refuge. The refuge plans to erect a memorial to Mr. Knapp and his accomplishments.

**SOCIOECONOMIC ENVIRONMENT**

The current area of Mackay Island National Wildlife Refuge lies in Currituck County, North Carolina, and Virginia Beach, Virginia. The refuge affects the environment, society, and economy of these counties more than any other area. The staff must consider the social and economic conditions of the counties in planning and implementing refuge activities. The land use in the communities influences the water and air quality in the water bodies surrounding the refuge and on the refuge. The relative availability of open space will affect the availability of land for wildlife habitat and the habitat off the refuge that wildlife use. The land protection step-

down plan will also consider land in Currituck County and Virginia Beach.

**Currituck County**. Currituck County is in the northeastern corner of North Carolina with the Atlantic Ocean to the east, Dare County, North Carolina to the south, Camden County, North Carolina to the west, and the city of Virginia Beach, Virginia to the north. The county is split into east and west segments by the Currituck Sound. The only bridge over the sound is in the southern part of mainland Currituck County that connects to northern Dare County on the Outer Banks, the barrier island next to the ocean. Knotts Island, where the refuge is located, is accessible by traveling from mainland Currituck County by road through the cities of Chesapeake and Virginia Beach, Virginia, or by ferry across the Currituck Sound.

Despite the difficulty of traveling in the county, Currituck County has experienced a great amount of growth in the last 30 years due its proximity to the city of Virginia Beach and the ocean. Unemployment and poverty rates are much lower than the state average.

Currituck County is still predominantly rural, and the largest town and county seat is Currituck (2000 population: 18,190). Like other rural areas throughout the country, outdoor activities are both popular and necessary. Hunting and recreational fishing are popular pastimes and farming, commercial fishing, and forestry are important elements of the economy.

**Virginia Beach**. Virginia Beach is in the southeastern corner of Virginia with the Atlantic Ocean to the east, Currituck County, North Carolina to the south, Chesapeake and Norfolk, Virginia to the west, and the Chesapeake Bay to the north. Virginia Beach has experienced steady growth in the last 120 years due its proximity to the ocean and access by water, railroad, highways, and air. Unemployment and poverty rates are much lower than the state average.

Virginia Beach occupies the area that was once Princess Anne County and is still 61 percent rural. Like other rural areas throughout the country, outdoor activities are both popular and necessary. Hunting and recreational fishing are popular pastimes and farming, commercial fishing, and forestry are still important elements of the economy.

*HISTORY*

Currituck County. The inhabitants of Currituck County at the time of European settlement were Coastal Algonkians. These Algonkians were the southernmost extent of a tribe that inhabited the Atlantic Coast north to Canada. They settled in relatively dispersed patterns with capital villages, villages, seasonal villages and camps for specialized activities. The settlements were along the sounds, estuaries, major rivers, and tributaries. Some of the villages had regular internal organization with palisades and some were less organized with an open structure. They settled where they could conduct agriculture, fishing, shell fishing, hunting, and gathering close to the village. The farmsteads were occupied by extended families. The Coastal Algonkians grew corn, squash, sunflowers, beans, and native plants on sandy ridges. They traded extensively with the Tuscarora that inhabited the area west of the Tidewater region (Mathis, M.A. and J.J. Crow 2000). The Algonkian called the area “Coratank” which means “The Land of the Wild Goose.”

The governor of colonial North Carolina established Currituck County in 1670 from part of Albemarle County. It was one of the five original ports in North Carolina and one of the first counties. The county built the original courthouse in 1723 and established the town of Currituck Court House in 1755. The county shortened the name of the county seat to Currituck. The government built the Currituck Beach Lighthouse in Corolla in 1875 on the Outer Banks to provide warning of the coast to ships at sea.

The first attraction to settlement was the abundant fish and game, which gave the county a reputation as a "Sportsmen's Paradise." John Mackie purchased Orphan's Island, on which the refuge is located, in 1761. The island became known as Mackie Island after his purchase and as Mackay Island after his death. In the early twentieth century, wealthy sportsmen established lavish hunting clubs in the county. These included the Whalehead Club in Corolla in 1922, the Monkey Island Hunt Club in 1931, and Joseph Knapp's estate on Mackay Island in 1918. Joseph Knapp was a wealthy publisher and insurance entrepreneur. He was a great philanthropist who contributed to and helped develop the education system in Currituck County. He also founded an organization known as "'More Game Birds in America" that is now known as "Ducks Unlimited." The Knapp estate was on the land that is now the Mackay Island National Wildlife Refuge where he experimented with wildlife management techniques.

As Virginia Beach has grown, suburban development has occurred on the mainland of Currituck County over the last thirty years. The Outer Banks portion of the county has grown rapidly since 1984, when the State of North Carolina extended Highway 12 ten miles north of Dare County into Currituck County. Extensive residential development of the dunes along the oceanfront began immediately after the highway was opened.

Virginia Beach. The inhabitants of Virginia Beach at the time of European settlement were also coastal Algonkians. There were 12,000 people living in a 9,000-square-mile-area. The tribes in the Tidewater area of Virginia included the Chesapeake, Powhatan, Arohatock, Appamattuck, Pamunkey, Youghtanund, and Mattaponi. All the tribes except the Chesapeake eventually surrendered to the Powhatan. All the tribes spoke the Powhatan dialect of the Algonquin language.

They settled in relatively dispersed patterns with capital villages, villages, seasonal villages and camps for specialized activities. The settlements were along the sounds, estuaries, major rivers, and tributaries. Some of the villages had regular internal organization with palisades and some were less organized with an open structure. They settled where they could conduct agriculture, fishing, shell fishing, hunting, and gathering close to the village. The farmsteads were occupied by extended families. The coastal Algonkians grew corn, squash, melons, pumpkins, sunflowers, beans, tobacco, and native plants on sandy ridges. They traded extensively with the Meherrin and Nottoway that inhabited the area west of the Tidewater region.

The first English colonists landed at the mouth of the Chesapeake Bay on April 26, 1607. They spent three days at the site of their first landing, erecting a cross and naming the spot Cape Henry. They later settled in Jamestown. In1635, Captain Adam Thoroughgood earned a land grant of 5,350 acres and persuaded 105 people to settle colonial Virginia Beach. The colonial governor formed Princess Anne County from the eastern section of Norfolk County in 1691, and named it in honor of the youngest daughter of King James. The livelihood of the early settlers depended on fishing. The early fishing industry prompted the dredging of the Lynnhaven Inlet to connect the Lynnhaven River with the Chesapeake Bay.

Princess Anne County had a continuous shoreline from the North Carolina border, north along the Atlantic Coast to Cape Henry, then west along the banks of the Chesapeake Bay to the Lynnhaven River. The extensive shoreline made merchant ships vulnerable to plundering by pirates. Until 1718 when Blackbeard was killed, piracy inhibited permanent settlement. Heavy ship traffic congested the waterways and resulted in many shipwrecks. Local volunteers lit bonfires to warn vessels of the shoreline. The state government built the Cape Henry Lighthouse in 1792 to facilitate safe passage.

The proximity of Virginia Beach to water also gave the area a role in the revolutionary war. The French cut off Cornwallis' British troops retreat route at Cape Henry and forced the surrender of the British at Yorktown in 1781. Continuing shipwrecks along the coast prompted the construction of five lifesaving stations in Virginia Beach along the coast until 1915 when the Coast Guard replaced them.

Virginia Beach has been a popular tourist resort since 1883 when railroad service began from Norfolk. Tourism has spawned the area's economy and further settlement to support that economy. The military has established four installations in Virginia Beach: Oceana Naval Air Station, Little Creek Amphibious Base, Fort Story Army Base, and Dam Neck Naval Base. These four bases and other military in adjacent cities have added support to the economy and attracted even more residents. The area is also a popular retirement location for retired military veterans.

The local economy has diversified over the years and new residents have located in Virginia Beach to work. The 2000 population was 425,257. The city of Virginia Beach and Princess Anne County merged in 1963, adding the rural areas in the southern part of the county to the city.

*LAND USE*

Currituck County. The historic land use in Currituck County depended for the most part on the nature of the land. Hydric soils cover seventy-seven percent of the county and they remained in forest or marsh until the twentieth century. The major historic land uses have revolved around hunting upland game and waterfowl as the county was known as a "Sportsmen's Paradise." Native Americans and farmers cultivated crops on the uplands for centuries. In the twentieth century, farmers drained much of the hydric mineral soil and shallow organic soil.

Today, Currituck County is 39 percent forested (64,343 acres), 29 percent marsh (47,921), and 18 percent cropland (29,592acres).

From 1997 to 2002, the land in farms decreased 12 percent from 39,571 acres to 34,802; the average size of farms decreased slightly, full-time farm operators increased 15 percent from 54 farms to 62 farms; total market value of agricultural products sold decreased 38 percent to $9,208,000; and average market value of agricultural products sold per farm decreased 35 percent from $174,005 to $112,294 (Table 12).

In 2002, soybeans accounted for 15,587 acres of cropland, the largest of any single crop in the county. Corn and wheat have also been important crops in Currituck County. Production of cotton and hogs had also been important, but there were not enough to report in 2002 (Table 13)(USDA 2002).

Within the refuge's approved acquisition boundary, the major land uses are farming and waterfowl hunting. There is little residential construction in the wetlands surrounding the refuge. The well-drained areas of the county have had extensive residential and commercial development.

Virginia Beach. The historic land use in Virginia Beach depended for the most part on the nature of the land. Hydric soils cover 74 percent of the city and they remained in forest or marsh until the twentieth century. Deep sandy dunes and beaches cover the eastern and northern side of the city. Access across the marshes and dunes restricted use of the barrier island.

The major historic land uses have revolved around fishing and hunting upland game and waterfowl. Native Americans and farmers cultivated crops on the uplands for centuries. In the twentieth century, farmers drained much of the hydric mineral soil and shallow organic soil. Development of the dunes and beaches along the ocean and the Chesapeake Bay began in 1883, when the railroad extended service from Norfolk.

Today, Virginia Beach is 39 (71,557 acres) percent developed, 25 percent forested (40,727 acres), 18 percent marsh (29,948 acres), and 14 percent cropland (23,873 acres).

From 1997 to 2002, the land in farms decreased 5 percent from 29,958 acres to 28,382 acres; the average size of farms decreased 20 percent from 204 acres to 164 acres; full-time farm operators decreased 10 percent from 71 farms to 64 farms; total market value of agricultural products sold decreased 29 percent from $13,638,000 to $9,661,000 and average market value of agricultural products sold per farm decreased 39 percent from $92,778 to $56,168 (Table 14).

In 2002, soybeans accounted for 13,306 acres of cropland, the largest of any single crop in the county. Corn and wheat have also been important crops in Virginia Beach. Production of hogs has also been important and has decreased so much it was not reported in 2002 (Table 15) (USDA 2002).

**Table 12. Currituck County agricultural statistics from the 2002 USDA Census of agriculture.**

| | |
|---|---|
| Number of Farms | 82 |
| Acres in Farms | 34,802 |
| Average Size of Farms (Acres) | 424 |
| Market Value of Land Per Farm | $1,324,800 |
| Market Value of Land Per Acre | $3,010 |
| Market Value of Equipment Per Farm | $100,534 |
| Total Cropland (Acres) | 29,594 |
| Market Value of All Products Sold | $9,208,000 |
| Market Value of Products Sold Per Farm | $112,294 |
| Market Value of Crops Sold | $8,918,000 |
| Market Value of Livestock Sold | $291,000 |
| Operators with Farm as Principal Occupation | 62 |
| Operators with Anther Occupation as Principal Occupation | 20 |
| Hogs in Inventory | 0 |
| Hogs Sold | 0 |
| Beef Cows in Inventory | 280 |
| Beef Cows Sold | 109 |
| Land in Soybeans (Acres) | 15,587 |
| Land in Corn (Acres) | 10,392 |
| Land in Wheat (Acres) | 7,576 |
| Land in Cotton (Acres) | 0 |

**Table 13. Commodity production in Currituck County in 2002 and 1997 from the 2002 and 1997 USDA Census of Agriculture**

| Commodity | 2002 Production | 1997 Production | 1997-2002 Change |
|---|---|---|---|
| Soybeans (Acres) | 15,587 | 18,489 | Decreased16% |
| Corn (Acres) | 10,392 | 11,309 | Decreased 8% |
| Wheat (Acres) | 7,576 | 9,880 | Increased 23% |
| Cotton (Acres) | 0 | 1,780 | N/A |
| Hog Inventory | 0 | 4,270 | N/A |
| Hogs Sold | 0 | 11,205 | N/A |
| Cattle Inventory | 280 | 290 | Decreased 3% |
| Cattle Sold | 109 | 188 | Decreased 42% |

**Table 14. Virginia Beach agricultural statistics from the 2002 USDA Census of agriculture.**

| | |
|---|---|
| Number of Farms | 172 |
| Acres in Farms | 28,382 |
| Average Size of Farms (Acres) | 165 |
| Market Value of Land Per Farm | $649,775 |
| Market Value of Land Per Acre | $3.645 |
| Market Value of Equipment Per Farm | $47,521 |
| Total Cropland (Acres) | 23,873 |
| Market Value of All Products Sold | $9,661,000 |
| Market Value of Products Sold Per Farm | $56,168 |
| Market Value of Crops Sold | $7,716,000 |
| Market Value of Livestock Sold | $1,945,000 |
| Operators with Farm as Principal Occupation | 90 |
| Operators with Other Occupation as Principal Occupation | 82 |
| Hogs Sold | 0 |
| Beef Cows Sold | 0 |
| Land in Soybeans (Acres) | 13,306 |
| Land in Corn (Acres) | 5,809 |
| Land in Wheat (Acres) | 7,928 |

**Table 15. Commodity production in Virginia Beach in 2002 and 1997 from the 2002 and 1997 USDA Census of agriculture.**

| Commodity | 2002 Production | 1997 Production | 1987-1997 Change |
|---|---|---|---|
| Soybeans (Acres) | 13,306 | 11,656 | Increased 12% |
| Wheat (Acres) | 3,143 | 7,928 | Decreased 60% |
| Corn (Acres) | 4,852 | 5,809 | Decreased 16% |
| Hog Inventory | 0 | 14,113 | N/A |
| Hogs Sold | 0 | 43,964 | N/A |
| Cattle Inventory | 0 | 259 | N/A |
| Cattle Sold | 0 | 166 | N/A |

*DEMOGRAPHICS*

**Currituck County**. Currituck County is primarily rural with a total estimated population of 18,190 in 2000 (U.S. Census Bureau 2000). The county gained 32 percent of its population between 1990 and 2000 (U.S Census Bureau, 2000). Currituck, the county seat, is the largest town but the population is widely dispersed throughout the unincorporated areas of the county.

The population is 90.4 percent White, 7.2 percent Black, 1.4 percent Hispanic, 0.6 percent Native American, and 0.4 percent Asian (U.S. Census Bureau 2000). In 2000, the mean family income was $36,287, slightly above the state average of $35,320. The poverty rate was 10.8 percent of the population, well below the state average of 12.6 percent (U.S. Census Bureau 2000). The average in 2004 was 2.8 percent, well below the State of North Carolina unemployment rate of 5.5 percent (North Carolina Employment Security Commission 2004).

The percentage of high school graduates in the population older than 25 years old is 77.6 percent; the percentage of college graduates is 13.3 percent. The state averages are 78.1 percent for high school and 22.5 percent for college (U.S. Census Bureau 2000). Home ownership rate is 81.6 percent, well above the state average rate of 69.4 percent. There are 2.61 persons per household in Currituck County, slightly above the state average of 2.49.

**Virginia Beach**. Virginia Beach is primarily a suburban community with a total estimated population of 425,257 in 2000 (U.S. Census Bureau 2000). The city gained 8.2 percent of its population between 1990 and 2000 (U.S Census Bureau 2000).

The population is 71.4 percent White, 19.0 percent Black, 4.9 percent Asian, 4.2 percent Hispanic, and 0.4 percent Native American (U.S. Census Bureau 2000). In 2000, the median family income was $48,705, a little above the state average of $46,677. The poverty rate was 6.5 percent of the population, well below the state average of 9.6 percent (U.S. Census Bureau 2000). The unemployment rate in November 2002 was 3.6 percent, slightly below the Commonwealth of Virginia unemployment rate of 3.7 percent (Virginia Employment Commission 2004).

The percentage of high school graduates in the population older than 25 years old is 90.4 percent; the percentage of college graduates is 28.1 percent. The commonwealth averages are 81.5 percent for high school and 29.5 percent for college (U.S. Census Bureau 2000). Home ownership rate is 65.6 percent, below the state average rate of 68.1 percent. There are 2.70 persons per household in Virginia Beach, slightly above the commonwealth average of 2.54.

*EMPLOYMENT*

**Currituck County**. Real estate is the largest employer in Currituck County, employing more than 500 of the county's 1,600 employees with an annual payroll of $25 million in 2000 (U.S. Department of Commerce, County Business Patterns 2000). This is due in large part to the Resort Quest of the Outer Banks (the largest single employer) that employs more than 500 employees (North Carolina Economic Security Commission 2002).

In 2000, the sectors employing the largest numbers of persons were in decreasing order as follows: real estate, retail trade, lodging and food service, health care, administrative and support services, and recreation (U.S. Census Bureau, Economic Census 1997).

**Virginia Beach**. The retail trade is the largest employer in Virginia Beach, employing 21,887 of 90,920 employees with an annual payroll of $1.5 billion in 2000 (U.S. Department of Commerce, County Business Patterns 2000).

In 2000, the sectors employing the largest numbers of persons were in decreasing order as follows: retail trade, hotel and restaurant industry, administrative support, professional services, health care and social assistance, manufacturing, wholesale trade, and real estate, recreation, and agriculture (U.S. Department of Commerce, County Business Patterns 2000).

*FORESTRY*

**Currituck County**. Timber has always been a source of wealth for Currituck County. However, much of the timber was cleared in order to cultivate the land for corn, soybeans, and other crops.

Today, Currituck County is approximately 39 percent forested, with 64,343 acres of forestland. In contrast, 60 percent of North Carolina is forested. Thirty-three percent of the County's forest is in oak-gum-cypress, 33 percent is in pine, 18 percent is in oak-pine, and 16 percent is in oak-hickory (USDA Forest Service 1991).

In 1990, private landowners were the largest forest landowner and owned 74 percent of the county's forested land. The state government owned 17 percent, forest industry owned 8 percent, and federal, county, and local governments owned 2 percent (USDA Forest Service 1991).

Despite the diminished wooded acreage, timber is still a large source of income for Currituck County. In 1990, the value of timber sold was $2.7 million. The payroll from forest products was $596,000 of the $1 million from all manufactured products (USDA Forest Service 1991).

**Virginia Beach**. In the past, timber was a source of wealth for Virginia Beach. However, much of the timber was cleared in order to cultivate the land for corn, soybeans, other crops, and more recently to develop residential and commercial projects.

**Table 16. Economic and population data for northeastern North Carolina counties.**

| County | Average Income[1] | Poverty Rate (%)[1] | Average 2004 Unemployment Rate (%)[23] | 2000 Population[1] | Population Trend[1] |
|---|---|---|---|---|---|
| **N. Carolina** | $35,320 | 12.6 | 5.5 | | +21% since 1990 |
| **Virginia** | $23,975 | 9.6 | 3.7 | | +14% since 1990 |
| **County in the Vicinity of the Mackay Island National Wildlife Refuge** | | | | | |
| **Currituck** | $36,287 | 10.8 | 2.8 | 18,190 | +166% since 1970 |
| **Dare** | $35,258 | 8.1 | 5.1 | 29,967 | +328% since 1970 |
| **Virginia Beach** | $22,365 | 6.5 | 3.6 | 425,257 | +8% since 1970 |
| **Other Northeastern North Carolina Counties** | | | | | |
| **Beaufort** | $28,614 | 17.4 | 6.9 | 44,958 | +6% since 1990 |
| **Bertie** | $22,816 | 12.6 | 8.2 | 19,773 | Same as 1990 |
| **Camden** | $35,423 | 12.2 | 3.8 | 6,885 | +16% since 1990 |
| **Carteret** | $34,348 | 11.8 | 4.7 | 59,383 | +13% since 1990 |
| **Chowan** | $27,900 | 18.7 | 4.9 | 14,526 | +7% since 1990 |
| **Craven** | $33,214 | 13.8 | 4.9 | 91,436 | +12% since 1990 |
| **Gates** | $30,087 | 15.4 | 4.2 | 10,516 | Same as 1900 |
| **Halifax** | $24,471 | 23.6 | 8.1 | 57,370 | Same as 1950 |
| **Hertford** | $23,724 | 23.1 | 8.0 | 22,601 | Same as 1960 |
| **Hyde** | $23,568 | 24.8 | 7.2 | 5,826 | -37% since 1900 |
| **Martin** | $26,058 | 20.1 | 7.1 | 25,593 | Same as 1940 |
| **Northampton** | $24,218 | 23.1 | 7.3 | 22,086 | Same as 1980 |
| **Pamlico** | $28,629 | 16.8 | 4.7 | 12,934 | +14% since 1990 |
| **Pasquotank** | $29,305 | 19.0 | 4.7 | 34,897 | +11% since 1990 |
| **Perquimens** | $26,489 | 19.5 | 4.8 | 11,368 | Same as 1920 |
| **Tyrrell** | $21,616 | 25.7 | 7.8 | 4,149 | -17% since 1900 |
| **Washington** | $27,726 | 20.5 | 7.3 | 13,723 | Same as 1960 |

[1] *U.S. Census Bureau, 2000 Census of the United States*
[2] *North Carolina Economic Security Commission, December, 2004*
[3] *Virginia Employment Commission, December, 2004*

Today, Virginia Beach is approximately 25 percent forested, with 40,727 acres of forestland. In contrast, 63 percent of Virginia is forested. Thirty-one percent of the city's forest is in pine, 30 percent is in oak-gum-cypress, 24 percent is in oak-hickory (USDA Forest Service 1992).

In 1990, private landowners owned 72 percent of the city's forested land. The forest industry owned 19 percent, the federal government owned 5 percent, the state government owned 2 percent, and county and local governments owned 2 percent (USDA Forest Service 1992).

*OUTDOOR RECREATION*

Fish and wildlife resources have had a profound effect on recreation in the area. Currituck County has always had an abundance of fish and game, due to its diversity of lands and waters. As early as 1918, sportsmen's clubs were created in the area for the purpose of protecting game and wildlife. Later, as part of a comprehensive wildlife management program, Mackay Island National Wildlife Refuge was created to preserve and restore habitat for native wildlife and migratory birds (Migratory Bird Conservation Act of 1929 [16 U.S.C. 715-715r, as amended] and Refuge Recreation Act of 1962 [16 U.S.C. 460-460k-4 as amended]). In addition to the refuge, two North Carolina state game lands and one Virginia wildlife management area are located in the area.

Recreation in the area is also based on the water in the North Landing River, Back Bay, Knotts Island Bay and the Currituck Sound. Boat ramps provide access to the river and sound. Numerous outfitters provide boats and guided tours. The North Carolina Coastal Plain Paddle Trails Guide lists a 10-mile trail along the Moyock Creek and Northwest River through the Northwest River Marsh Game Land in Currituck County (North Carolina Division of Parks and Recreation 2001). The State of North Carolina owns the 2,958-acre Northwest River Marsh Game Land in Currituck County and the 14,657-acre North River Game Land in Camden and Currituck Counties for wildlife management and hunting opportunities. The Commonwealth of Virginia owns the 1,546-acre Princess Anne Wildlife Management Area, 4,321-acre False Cape State Park, 2,000-acre First Landing State Park, 3,441-acre North Landing River Natural Area Preserve, and the 2,417-acre Northwest River Natural Area Preserve. The city of Virginia Beach owns 3,200 acres of land in parks.

Local events that revolve around natural resources include the Knotts Island Wildlife Festival, Whale Watching and Dolphin Watching Boat Trips in Virginia Beach, Wildlife Arts Show and Waterfowl International Art Show in Virginia Beach, and fishing tournaments in Virginia Beach.

*OUTDOOR RECREATION ECONOMICS*

Fish and wildlife are the focuses of the refuge, but they are also important to the local economy. First, a commercial fishery is present in the Currituck Sound. Blue crab and flounder are the major species harvested. Second, hunting and fishing are economically important to local businesses, both directly as the local population spends money, and indirectly as an attraction that draws sportsmen from outside the county.

Unfortunately, a general lack of regard for the preservation of fish and wildlife resources combined with wetland clearing and draining, has led to the loss of valuable fishery spawning grounds and the loss of habitat for many wildlife species. In the attempt to restore and protect some of these resources, Mackay Island National Wildlife Refuge serves an important role, not only by providing habitat for a diversity of plant and wildlife species, but also as a place where people can go to enjoy these resources, either through observation, photography, hunting, or fishing.

The Fish and Wildlife Service surveyed participants in wildlife-dependent recreation in North Carolina in 2001. The survey documented an average expenditure of $69 per day by anglers, $74 per day by hunters, and $199 per day by wildlife observers and photographers (U.S. Fish and Wildlife Service 2001).

The Partnership for the Sounds had a study conducted on the economic impact of its facilities. The study demonstrated that the average visitor spent $108 per visit, with a range of $63.70 to $332.55 per day (Vogelsang 2001). A similar study of visitors at the Chincoteague National Wildlife Refuge in Virginia also showed a range of expenditures from $62 to $101 per day (U.S. Environmental Protection Agency 1997).

Ecotourists on Dauphin Island, Alabama spent an average of $60 per visitor per day (Kerlinger 1999). Bird watchers on High Island, Texas from the local area reported an average expenditure of $46 per day: and non-residents reported $693 per trip (Eubanks, Kerlinger, Payne 1993). The average visitor to the Great Texas Coastal Birding Trail spent $78 per day (Eubanks and Stoll 1999).

Studies at the Santa Ana National Wildlife Refuge in south Texas demonstrated a range of expenditures from $88 to $145 per day on nature based tourist activities. The Laguna Atascosa National Wildlife Refuge in south Texas reported a range of $83 to $117 per day (U.S. Environmental Protection Agency 1997).

Bird watchers to the Salton Sea National Wildlife Refuge in California spent an average of $57 per day (National Audubon Society 1998).

When improved access, facilities, and staffing are added, Mackay Island National Wildlife Refuge can serve as an important commodity in the economic life of the community. Local officials consider eco-tourism, hunting, fishing, wildlife observation and photography, and environmental interpretation elements of a desirable industry. As the population increases and the number of places left to enjoy wildlife decreases, the refuge may become even more important to the local community. It can benefit the community directly by providing recreational opportunities for the local population, and indirectly by attracting tourists from outside the parish to generate additional dollars to the local economy.

*TOURISM*

Tourism in the area is based on the natural resources and cultural attractions in the area. Boat ramps provide access to the rivers, bays, and sounds for fishing, hunting, and boating. Numerous outfitters provide boats and guided tours. The oceanfront attracts swimmers, surfers, sunbathers, and anglers to both Virginia Beach and the Outer Banks of Currituck County. Virginia Beach attracts three million tourists per year.

More developed tourist attractions based on natural resources include Currituck National Wildlife Refuge, National Estuarine Research Reserve, and feral horses on the Outer Banks of Currituck County. Others in Virginia Beach include Back Bay National Wildlife Refuge, First Landing and False Cape State Parks, Munden Point City Park, Chesapeake Bay Center, and the Virginia Marine Science Museum.

Mackay Island National Wildlife Refuge could serve as an additional attraction to tourists visiting the area. If the Service provided better roads and more facilities within the refuge, tourists might stay longer in the area to enjoy the opportunities provided for wildlife-dependent recreation and environmental education. This could generate more income for the local economy.

*TRANSPORTATION*

In its early days, residents of the area relied on water transportation. The rivers and streams that crisscross the counties served as a means for transportation, trade, and communication between almost every community in the area. The North Landing River, Back Bay, and Currituck Sound were once the major transportation avenues in the area. As the area grew and the railroad arrived, river and boat traffic declined. The waterways are still important as sources of income and for recreation. A ferry operated by the North Carolina Department of Transportation carries 78,000 people per year from Knotts Island to Currituck, North Carolina.

In the twentieth century with the popularity of automobiles, the state developed a network of highways connecting the county to all areas of the eastern United States. State Route 168 and U.S. Highway 158 connect the Outer Banks with the Virginia Beach, Norfolk and Chesapeake areas through the mainland part of the county. Interstate 64 connects the county with the northeastern United States. A number of smaller roads connect the various communities in the area. There is an international airport in Norfolk/Virginia Beach.

*CULTURAL ENVIRONMENT*

Virginia Beach is in a major metropolitan area that supports a wide range of cultural facilities and events. The Virginia Beach Pavilion is a 63,000 square foot convention center that hosts dozens of events annually from craft shows to musical and theatrical performances. The Little Theater of Virginia Beach hosts plays throughout the year. The 20,000-seat Virginia Beach Amphitheater is the site of live musical performances. The Contemporary Art Center of Virginia features changing exhibitions by national and international artists as well as performing arts performances. It attracts 400,000 visitors annually. The Atlantic Wildfowl museum celebrates the art of decoy making that was instrumental in attracting the first settlers to the area.

The Scope in Norfolk is a 12,600-seat arena that hosts live music performances as well as sports events. The 2,400-seat Chrysler Hall is the site of theatrical performances. The historic Wells Theater is the 600-seat home to the Virginia Stage Company. The 675-seat Attucks Theater is the site of African-American stage performances. The 1632-seat Harrison Opera House is home to the Virginia Opera. The Chrysler Museum of Art is a venue for 30,000 paintings, sculptures, and decorative arts from the world over. The 12,067-seat Harbor Park is home to the Norfolk Tides baseball team.

**REFUGE ADMINISTRATION AND MANAGEMENT**

The Fish and Wildlife Service administers Mackay Island National Wildlife Refuge located on Knotts Island along the North Landing River. The refuge staff administers 8,219 acres of fee title land in Currituck County, North Carolina, and Virginia Beach, Virginia, and 4,383 acres of the fee title land and 3,931 acres of conservation easement land at the Currituck National Wildlife Refuge on the Outer Banks of Currituck County, North Carolina. The marshes on the western edge of Currituck National Wildlife Refuge are located 6 miles east of the Mackay Island Refuge headquarters across the Currituck Sound. The western marshes are ½-mile east of the boat ramp on Knotts Island Bay; the upland portion of the refuge is 2 miles east of the boat ramp. It is 100 miles and almost a 3-hour drive to the Currituck Refuge around the Sound by roads (Figure 1).

LAND PROTECTION AND CONSERVATION

Congress established the Mackay Island National Wildlife Refuge on December 30, 1960, by the authority of the Migratory Bird Conservation Act of 1929. The Service established the original acquisition boundary of 7,835 acres in 1961 and expanded the boundary to 9,503 acres in 1991 (Figure 5). The Secretary of the Interior issued a proclamation on August 21, 1963, prohibiting waterfowl hunting on 4,621 acres of the refuge and 1,098 acres of water south and west of the refuge.

The Service also manages the 8,000-acre Currituck National Wildlife Refuge on the Outer Banks of Currituck County, North Carolina, the 8,000-acre Back Bay National Wildlife Refuge in Virginia Beach, Virginia and the 110,000-acre Great Dismal Swamp National Wildlife Refuge in Suffolk, Virginia.

The proposed acquisitions qualified for funding under the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715-715R) and the Refuge Recreation Act of 1962 (16 U.S.C. Sec 460k-1).

There are lands in the area protected by other agencies and organizations. The State of North Carolina owns the 2,958-acre Northwest River Marsh Game Land in Currituck County and the 14,657-acre North River Game Land in Camden and Currituck Counties for wildlife management and hunting opportunities. The Commonwealth of Virginia owns the 1,546-acre Princess Anne Wildlife Management Area, 4,321-acre False Cape State Park, 2,000-acre First Landing State Park, 3,441-acre North Landing River Natural Area Preserve, and the 2,417-acre Northwest River Natural Area Preserve. The city of Virginia Beach owns 3,200 acres of land in parks.

The Nature Conservancy protects the 7,533-acre North Landing River Preserve in southwestern Virginia Beach.

**VISITOR SERVICES**

*HUNTING*

Hunting and fishing are the primary recreational activities conducted on the Mackay Island project area. Historically, hunting was primarily confined to those hunters who belonged to hunt clubs within the project area. Hunt clubs are social organizations that have traditionally used the marshes around Currituck Sound, Back Bay, and Knotts Island Bay for hunting purposes and are found throughout the refuge's project area. The land is generally leased on a yearly basis. Before the service acquired the land, five hunt clubs operated within the refuge's approved acquisition boundary. The refuge has held deer hunts since 1981. There are currently 450 annual hunter-use-days for the deer hunt.

*FISHING*

The refuge canals and moist-soil units are open to fishing. The refuge has a fishing pier that is accessible to the disabled. There are currently 15,000 annual angler-use-days on the refuge.

*ENVIRONMENTAL EDUCATION*

The refuge does not have a developed environmental education program. Staff has taken groups out on the refuge to teach them about the marsh ecosystem and the wildlife that inhabit the marsh. There are currently 100 students that use the refuge annually.

**Figure 5. Approved acquisition boundary at the Mackay Island National Wildlife Refuge**

*INTERPRETATION*

The refuge has developed a 0.3-mile-long interpretive trail, located off the south side of North Carolina Highway 615. At the head of the trail is an interpretive kiosk. There are also interpretative kiosks at the wildlife observation platform on the north side of North Carolina Highway 615 and along Knotts Island Road on the refuge. The wildlife observation platform and kiosk are part of the Kuralt Trail system that connects the eleven national wildlife refuges in the Roanoke-Tar-Neuse-Cape Fear ecosystem in northeastern North Carolina and southeastern Virginia. There are currently 5,000 visitors to the refuge for interpretation annually (Figure 6).

*WILDLIFE OBSERVATION*

There is a wildlife observation platform on the north side of North Carolina Highway 615. The wildlife observation platform and kiosk are part of the Kuralt Trail system that connects the eleven national wildlife refuges in the Roanoke-Tar-Neuse-Cape Fear ecosystem in northeastern North Carolina and southeastern Virginia. Visitors can also observe wildlife along a 0.3-mile-long interpretive trail, located off the south side of North Carolina Highway 615 and the refuge's 9.2 miles of roads. There are currently 70,000 visitors to the refuge annually for wildlife observation.

*WILDLIFE PHOTOGRAPHY*

There are no photography blinds available for public use. However, visitors can photograph wildlife on the refuge in areas not restricted to access during refuge use hours. There are currently 700 visitors to the refuge annually for wildlife photography.

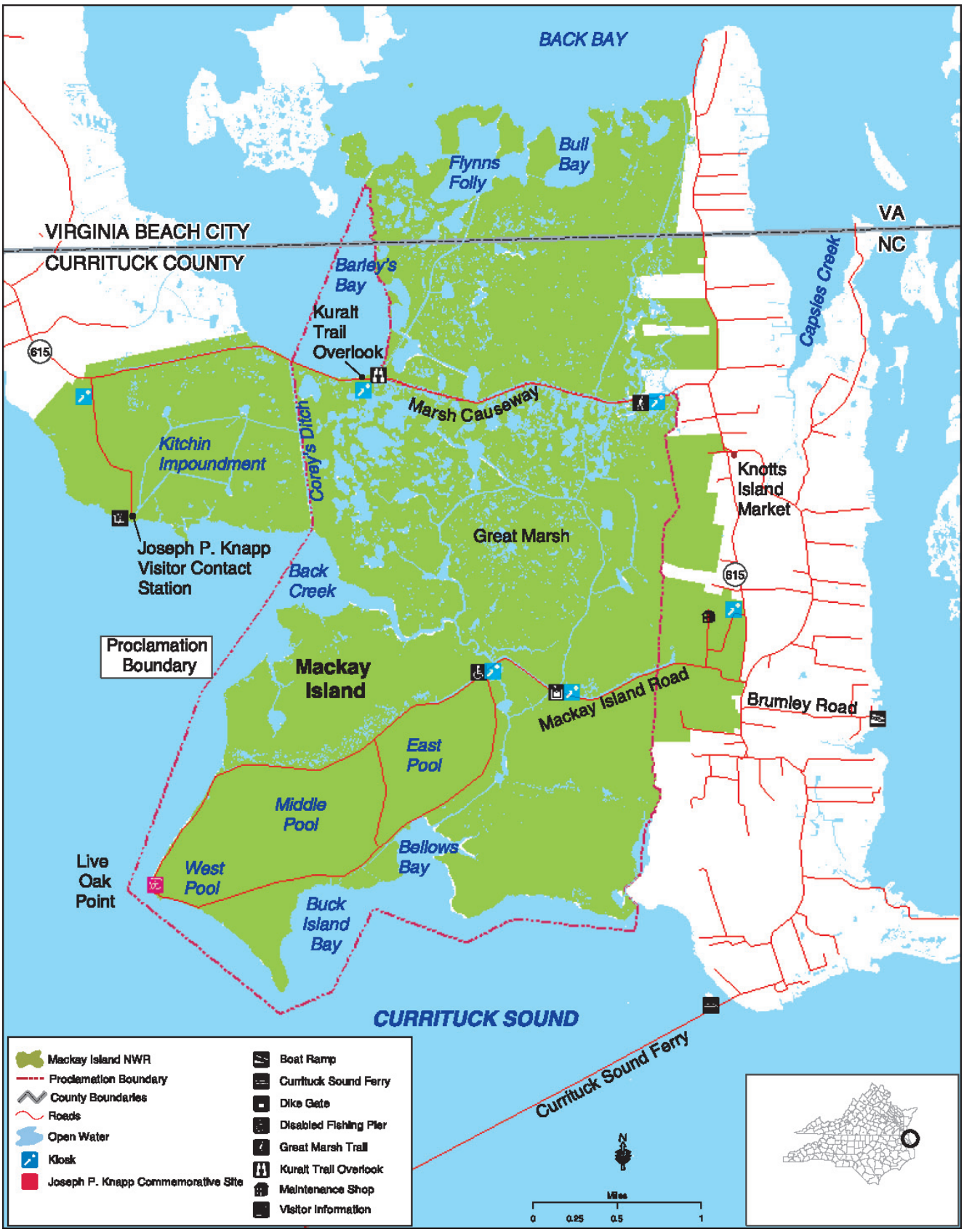
**PERSONEL, OPERATIONS AND MAINTENANCE**

The refuge's staff currently manages both Mackay Island and Currituck Refuges and includes the seven positions listed below in Table 17.

**Table 17. Staff of Mackay Island and Currituck National Wildlife Refuges – 2005.**

| Position | Status | Percent of Time on Mackay Island |
|---|---|---|
| **Refuge Manager, GS-0485-13** | PFT | 55 |
| **Assistant Manager, GS-0485-09** | PFT | 65 |
| **Park Ranger (Law Enforcement), GS-0026-09** | PFT | 25 |
| **Office Assistant, GS-0303-05** | PFT | 85 |
| **Maintenance Mechanic, WG-4749-10** | PFT | 85 |
| **Engineering Equipment Operator, WG-5716-08** | PFT | 60 |
| **Forestry Technician, GS-0462-05) (Fire)** | PFT | 60 |
| *PFT = permanent full time, TFT = temporary full time, Fire = Funded by Fire Budget* | | |

**Figure 6. Current visitor facilities at Mackay Island National Wildlife Refuge**



The Fish and Wildlife Service administers Mackay Island National Wildlife Refuge from an office located on Knotts Island along the Currituck Sound in the southwestern corner of the refuge. The refuge staff administers 8,219 acres of fee title land of the Mackay Island National Wildlife Refuge in Currituck County, North Carolina, and Virginia Beach, Virginia. The Service houses the maintenance and fire personnel at a shop facility on the eastern edge of the refuge.

Most of the land is wetlands and much of those wetlands have peat soils that cannot support equipment, roads, or buildings. The refuge has a road and drainage ditch system installed by previous owners. The principal habitat management activity is water management to provide optimum conditions for waterfowl, wading birds, and shorebirds in managed wetlands. The staff conducts prescribed fire according to the fire management plan and maintains roads and roadsides as firebreaks to manage wildfires. Cooperative farmers manage the refuge cropland.

## REFUGE INFRASTRUCTURE

### *ROADS AND TRAILS*

There are 9.2 miles of roads on the refuge. The roads around the managed wetlands (moist-soil units) make up most of the refuge's road and trail system. A 0.3-mile trail is on the south side of North Carolina Highway 615.

### *UTILITY CORRIDORS AND DISTRIBUTION*

The only dedicated utility corridor follows North Carolina Route 615 along the marsh causeway. This corridor carries cable, phone, and power to the community of Knott's Island. There are also smaller segments of this distribution network that traverse refuge properties east of North Carolina Route 615 on Knott's Island. Additional service corridors provide power and phone service to the shop, quarters, fire cache, and office buildings.

### *COMMUNICATION SYSTEM*

The refuge communications system is analog mobile radios with a base station. One repeater is used to extend the radios' range. In some places, cellular phones are used for communication between the field and office. The radio system is scheduled to be replaced with digital band radios to meet Department of Interior mandates.

### *SOLID WASTE COLLECTION AND DISPOSAL*

Presently, a commercial vendor manages solid waste. The staff places waste into a dumpster and the vendor transports it to an approved collection disposal facility.

# III. Plan Development

## THE PLANNING PROCESS AND ASSOCIATED ISSUES

Representatives from the Fish and Wildlife Service and state wildlife agency personnel attended initial planning meetings. At these initial meetings, they discussed strategies for completing the plan, identified issues and concerns, and compiled a mailing list of likely interested government agencies, non-governmental organizations, businesses, and individual citizens. The Service invited these agencies, organizations, businesses, and citizens to participate in four public scoping meetings. The audiences were introduced to the refuge and its planning process and they were asked to identify their issues and concerns.

These meetings were held on June 19, 21, 26, and 28, 2001, in Currituck, North Carolina; Corolla, North Carolina; Virginia Beach, Virginia; and Knotts Island, North Carolina. The Service published announcements giving the location, date, and time for the public meetings in the Federal Register and legal notices in local newspapers. Press releases were sent to local newspapers and public service announcements were sent to television and radio stations. Service personnel placed fifty posters announcing the meetings in local post offices, local government buildings, and stores.

The planning teams expanded the issues and concerns to include those generated by the agencies, organizations, businesses, and citizens from the local community. These issues and concerns formed the basis for the development and comparison of the objectives in the different alternatives described in the environmental assessment (Section B).

The objectives were subjects of discussion at a second round of public meetings on November 18, 19, 20, and 21, 2002, in Corolla, Currituck, and Knotts Island, North Carolina, and Virginia Beach, Virginia. The Service published announcements giving the location, date, and time for the public meetings as legal notices in local newspapers. They also sent press releases to local newspapers and public service announcements to television and radio stations. Service personnel placed seventy-five posters announcing the meetings in local post offices, local government buildings, and stores.

### *PLAN REVIEW AND REVISION*

The staff will review this comprehensive conservation plan annually to determine the need for revision. A revision would occur if and when major changes in ecological conditions occur or the Service plans a major expansion. The staff will augment the final plan by detailed step-down management plans and annual plans to address the completion of specific strategies in support of the refuge's goals and objectives. Revisions to the comprehensive conservation plan and the step-down management plans would be subject to public review and compliance with the National Environmental Policy Act.

### *PLANNING ISSUES AND CONCERNS*

A number of issues and concerns were generated from the input of local citizens and public agencies, the team members' knowledge of the area, and the resource needs identified by the staff and biological review team. A Fish and Wildlife Service planning team was assembled to evaluate the resource needs. The team then developed a list of goals, objectives, and strategies to shape the management of the refuge for the next 15 years.

These issues provided the basis for developing the refuge's alternative management objectives and strategies. These issues played a role in determining the desired conditions for the refuge and were considered in the preparation of the long-term comprehensive conservation plan. The issues and concerns are described below. They are of local, regional, and national significance and reflect similar issues that were, in part, identified by the public at the planning meetings.

**Hydrology**

*Drainage*

Previous landowners have dug drainage ditches to facilitate crop production and access for hunting. The ditches effectively lower the water table draining subsurface water in the vicinity of the ditch. They also impound water behind the piles of soil excavated from the ditches and allow water from the rivers, bays, and sounds to flow into the wetlands of the refuge more rapidly than it would naturally. The drainage affects the plant communities on the refuge by providing habitat for species adapted to better drainage close to the ditches and on the tops of spoil piles. The flooding of areas behind the spoil piles inhibits plant regeneration and favors species that are better adapted to more persistent and frequent flooding than would have occurred naturally. Mackay Island Road and North Carolina State Route 615 have also altered historic drainage patterns throughout the marsh.

*GLOBAL WARMING AND SEA LEVEL RISE*

Most of the refuge lies at or within a few feet of sea level. Much of the refuge has a water table within a foot of the soil surface. Marshes cover the majority of the refuge. Wetland forest stands cover the most of the balance of the refuge. Scientists predict that the sea level along the North Carolina coast will rise from two to three feet in the next 100 years due to global warming. That rise in water levels will change the types of vegetative cover on the refuge. The grass-dominated marshes that occupy the majority of the refuge will lie below sea level and will become open water areas. The marshes will expand into areas currently covered by forest trees.

As the habitats change, the wildlife species that inhabit those habitats will also change. Wading birds, waterfowl, and marsh birds that use the marshes for cover, feeding, and nesting will loose that kind of habitat. Neotropical migratory songbirds and wood ducks that currently utilize trees will loose their feeding and nesting sites as trees die and fall. The species that utilize the areas that are currently marsh will move upslope as the marshes replace the trees.

**Fish and Wildlife Populations**

*Threatened and Endangered Species*

Recovery and protection of threatened and endangered plants and animals is an important responsibility delegated to the Service and its national wildlife refuges. Three threatened or endangered animals are thought to use (or could use) Mackay Island National Wildlife Refuge: the bald eagle, red-cockaded woodpecker, and West Indian manatee.

Threatened bald eagles nest on Mackay Island National Wildlife Refuge. They also nest in adjacent counties and travel the river corridor and shoreline of the Sound. The refuge's habitat protection and management activities provide suitable habitat for nesting eagles.

Records of the occurrence of endangered red-cockaded woodpeckers in Currituck County are more than twenty years old. There is suitable habitat on the refuge in the coastal fringe evergreen forest. As the forest ages and pine trees develop suitable nesting cavities, the refuge could support woodpeckers. Sustaining viable populations will require proper understory management.

Endangered West Indian manatees are occasionally cited in Currituck County and areas further north, but Currituck County is outside the normal range of the manatee.

*Waterfowl*

The scoping process identified the management of all refuge marshes, managed wetlands (moist-soil units), and forests for waterfowl and expanding waterfowl hunting opportunities as issues. In order to meet the refuge's waterfowl purpose, the refuge must maintain the marsh, forest, and managed wetlands (moist-soil units) to meet waterfowl habitat needs and provide sufficient sanctuary areas to provide undisturbed resting and feeding areas for waterfowl. The Service can provide waterfowl hunting opportunities as the refuge acquires additional land outside the proclamation boundary within which the Service prohibits waterfowl hunting. The core waterfowl sanctuary needs to remain intact to meet the undisturbed resting and feeding needs of waterfowl.

The refuge's waterfowl purpose guides all operation and management actions on the refuge. The refuge manages forested wetlands to meet the feeding, resting, and breeding needs of migratory and resident waterfowl. Staff of the Fish and Wildlife Service and cooperating agencies and organizations conducted a biological review of Mackay Island National Wildlife Refuge in 1999 and 2000, as part of the comprehensive conservation planning process. They identified objectives to meet the minimum water, food, sanctuary, and resting/loafing habitat requirements of waterfowl.

*Neotropical Migratory Birds*

Neotropical migratory birds are a species group of special management concern. Providing habitat (i.e., forest and marshes) for these birds is one of the refuge's major objectives. Strategic forest management compatible with the refuge's waterfowl habitat objectives would contribute to the forest needs of neotropical migratory birds. The biological review cited in the Waterfowl section above identified objectives needed to meet the minimum feeding and nesting habitat requirements of neotropical migratory birds. The neotropical migratory birds are also a major focus of the refuge wildlife observation program as many birders visit the refuge to observe nesting, feeding, and loafing birds.

**Habitats**

*Brackish Marsh and Managed Wetlands*

Participants at the public scoping meetings held to solicit input to the plan expressed strong support for continued intensive management of the marshes and managed wetlands (moist-soil units) along the North Landing River, Back Bay, and Currituck Sound. They were well aware of the connection between that management and opportunities for hunting on adjacent lands (primarily for waterfowl).

Mackay Island River National Wildlife Refuge is near several large marshes in the South Atlantic Coastal Plain Physiographic Zone. Cooperative private-state-federal partnerships under the North American Waterfowl Management Plan, Partners-in-Flight, and the Atlantic Coast Joint Venture recommend maintenance and stabilization of the marsh. With strategic management, the staff can provide quality marsh habitat with the proper water management, prescribed burning, and aquatic weed control.
*Forests*

There is public recognition of the role of the refuge's small forest area in white-tailed deer and neotropical migratory bird populations and the public use associated with deer hunting and bird-watching. At the scoping meetings, the public also expressed an appreciation for the function of the forest in support of other aspects of the refuge's public use program. The refuge has not developed a management plan for its forestlands, but does treat insect and disease infestations as they occur and conducts prescribed burning as opportunities present themselves. The public encouraged the refuge staff to make forest management a higher priority. A biological review in 2002 recognized the importance of a forest assessment. The review also found that an active forest management program would be difficult to maintain due to limited forest areas.

**Public Use**

*Visitor Services and Education*

The refuge is in Currituck County, North Carolina (2000 population 18,190), and Virginia Beach, Virginia (2000 population 425,257), within 27 miles of the Virginia Beach business district. There is a need to promote nature-based tourism in northeastern North Carolina in the rural counties that have an abundance of natural resources to attract tourists, but are dominated by wetlands that limit traditional economic development. Virginia Beach attracts three million tourists per year and another 78,000 people drive past the refuge to use the ferry to travel from Knotts Island to Currituck, North Carolina. A few commercial interests guide canoeing and angling adventures. The refuge is an important link to the other natural areas that together make these experiences possible. Carefully selected and managed staff, programs, and facilities will provide the wildlife-dependent environmental education, interpretation, and recreation opportunities the refuge's visitors expect. The refuge will require additional staff support to achieve the refuge's visitor service potential.

*Hunting*

Hunting is an integral part of rural North Carolina culture. It is not surprising that there is a considerable interest from the state agencies and the local citizens in expanding hunting opportunities. The initial refuge strategy must be maintenance of the quality of hunting at existing levels. Any additional hunting opportunities will be dependent on providing safe, quality experiences that are compatible with refuge purposes. The refuge requires additional law enforcement personnel to administer additional deer hunts. There may be an opportunity to add additional hunting opportunities on the refuge.

*Fishing*

Anglers utilize the refuge ditches, impoundments, a boat ramp on Mackay Island Road, and the handicapped accessible fishing pier for fishing opportunities. The public expressed an interest in improving access to the refuge for fishing. The refuge has the potential to add a boat ramp and expand safe access to bank fishing areas.

*Roads and Trails, Exterior and Interior*

The Service limits access to the office and Kitchin impoundment to the hours of 7:30AM to 4:00PM Monday through Friday. It limits access to the remainder of the Refuge to daylight hours from March 15 to October 15. The public expressed an interest in more access to the Refuge. As the Refuge adds staff to work weekends, it can consider increasing access to the office area and the remainder of the Refuge. The Refuge must limit access to areas where bald eagles nest and waterfowl rest and feed when the birds are in the areas to minimize disturbance.

## Resource Protection

*Cultural Resources*

Local residents, the refuge staff, and the Fish and Wildlife Service in the regional and national office are all aware of the importance of the Mackay Island National Wildlife Refuge as the former home of Joseph P. Knapp, who founded "More Game Birds in America," which later became Ducks Unlimited. Mr. Knapp was a wealthy philanthropist from New York who modernized the education system in Currituck County. Historians widely recognize his legacy in wildlife management and education reform in the county. The public encouraged the refuge staff to continue to interpret Mr. Knapp's contributions to the area.

There are thirteen cemetery plots on the refuge. The refuge has noted their locations on maps in the refuge office.

*Land Acquisition and Habitat Fragmentation*

When it was established, the refuge's role in providing managed wetlands (moist-soil units) and brackish marsh was providing additional habitat types for migratory waterfowl. Reevaluation has determined that those habitats are as important for marsh birds and neotropical migratory songbirds (in support of Partners-in-Flight) as they are for waterfowl habitat. The refuge's current acquisition boundary reflects the importance of protecting and managing the most valuable brackish marsh. The Service has identified a few private properties in an internal land protection plan (U.S. Fish and Wildlife Service 1994) that have value as marsh habitat and cropland for high energy foods for migrating waterfowl, but they are outside the refuge acquisition boundary. Those properties are important links in protecting areas along Back Bay, North Landing River, and Currituck Sound. To maintain the potential to protect these lands, the Service must have the ability and authority to manage and protect (through acquisition of fee title interest or conservation easements) the important habitat beyond the refuge's current acquisition boundary. Also, acquisition of fee title interest in new lands will provide expanded public use opportunities when compatible; conservation easements would not.

*Law Enforcement and Refuge Regulation*

The refuge has enforced the applicable laws and regulations through the use of one full-time law enforcement officer shared with Currituck National Wildlife Refuge and one dual function officer, currently the refuge manager. The use of dual function officers to perform enforcement functions utilizes a great deal of the time they could devote to refuge administration and support of the biological, public use, and maintenance programs. This is particularly evident during hunting season when the law enforcement workload is at its highest. They are limited in their enforcement authority on the Currituck National Wildlife Refuge's easement properties and must rely on state and county law enforcement officers to assist them. They are also limited in the amount of time they can devote to permit monitoring and enforcement of the conditions on the permits.

*Other Resource Protection*

There are other threats to refuge resources that require closer monitoring and management. Pest plants, such a phragmites, animals, such as nutria, and wildlife disease are all concerns to which the refuge, with adequate personnel and funding, should be paying closer attention.

## General Administration

*Funding and Staffing*

Funding has been insufficient to support refuge programs. Inadequate staff, facilities, and equipment have prevented the refuge from realizing its purpose and management objectives. Currently, the refuge is not meeting its wildlife habitat objectives beyond moist-soil units. It conducts few wildlife inventories beyond waterfowl; has few public use facilities; has outdated habitat/wildlife management plans; and provides few non-hunting or fishing wildlife-dependent recreational opportunities. The refuge only addresses other priority public uses (environmental education, interpretation, wildlife observation, wildlife photography) as the public requests them. The assistant manager performs the functions of a wildlife biologist and outdoor recreation planner as well as those for which he/she was hired. The refuge needs additional staff to meet its objectives. The biological and public use programs are currently the greatest needs.

# *IV. Management Direction*

**VISION**

The vision for the refuge is as follows:

The Mackay Island National Wildlife Refuge will provide habitat for migratory birds and endangered species as an integral part of the National Wildlife Refuge System. The refuge will restore, enhance, and maintain the health and diversity of wildlife habitats within the Back Bay and Currituck Sound watersheds. The refuge will also provide opportunities for compatible wildlife-dependent recreation. The refuge will develop and maintain partnerships with other agencies and organizations to accomplish its goals and objectives.

**GOALS**

Wildlife, Fish, and Plant Populations: Preserve, protect, and maintain healthy and viable populations of birds, wildlife, fish, and plants, including federal and state endangered species and trust species.

Habitat: Restore, enhance, and maintain the health and biodiversity of brackish marsh, forests, and other habitats to ensure optimum ecological productivity and protect the water quality of Currituck Sound and Back Bay.

Public Use: Provide the public with safe, quality wildlife-dependent recreational and educational opportunities that focus on the wildlife and habitats of the refuge and the National Wildlife Refuge System.

Resource Protection: Protect refuge resources by limiting adverse impacts of human activities and development.

Administration: Acquire and manage adequate funding, human resources, facilities, equipment, and infrastructure to accomplish the other refuge goals.

**OBJECTIVES AND STRATEGIES**

The goals, objectives, and strategies addressed below are the Service's response to the issues, concerns, and needs expressed by the planning team, the refuge staff, and the public. These goals, objectives, and strategies reflect the Services' commitment to achieve the mandates of the National Wildlife Refuge System Improvement Act of 1997, the mission of the National Wildlife Refuge System, the North American Waterfowl Management Plan, and the purpose and vision for Mackay Island National Wildlife Refuge. Depending upon the availability of funds and staff, the Service intends to accomplish these goals, objectives, and strategies during the next 15 years.

*GOAL 1. FISH AND WILDLIFE POPULATIONS*

**Objective 1: Fish**
Manage resources to protect species of fish and other aquatic organisms on the refuge and adjacent waters.

Discussion: This alternative provides for surveys of fish and aquatic organisms, and interpretation of the results of those surveys. As funds from grants become available or partners express an interest in conducting research on the refuge, they would perform more intensive surveys.

There are fish and other aquatic organisms in the managed wetlands (moist-soil units) and ditches on the refuge. These species provide the prey base for mammals and birds on the refuge and the basis for recreational fishing opportunities. There is no database documenting the diversity or population of the species on the refuge, or the effect of management on the species. This alternative provides for the inventory of fishery resources.

*Strategies:*

- Cooperate with other agencies, universities, and organizations performing studies and investigations on the refuge.

- Inventory fishery resources and explore management options in consultation with the technical assistance office fisheries biologist within five years.

**Objective 2: Invertebrate Species**
Document the diversity and populations of invertebrate species.

Discussion: This alternative does not provide for surveys of invertebrate species, but does provide for documentation of their presence. As funds from grants become available or partners express an interest in conducting research on the refuge, they would perform more intensive surveys.

There are invertebrate species on the refuge that provide the prey base for mammals, reptiles, amphibians, fish, and birds. There is no database documenting the diversity or population of the species on the refuge, or the effect of management on the species. This alternative provides for documentation of invertebrates as they are identified.

*Strategies:*

- Document presence of invertebrate species as they are identified.

- Cooperate with other agencies, universities, and organizations performing studies and investigations on the refuge.

**Objective 3: Land Birds**
Provide resting, nesting, and foraging habitat for about 115 species of land birds.

Discussion: This alternative provides for development of an inventory protocol and surveys of land birds. As funds from grants become available or partners express an interest in conducting research on the refuge, they would perform more intensive surveys.

There are 115 species of avian species on the refuge, some of which breed on the refuge and others that rest and feed on the refuge during migration. Many of the species are birds identified as high priority by Partners-in-Flight, a group of scientists from state and federal agencies, universities, and non-governmental organizations that studies and manages migratory bird populations. The birds are the basis for much of the refuge's wildlife observation and photography. There is no database documenting the diversity or population of the species on the refuge, or the effect of management on the species.
*Strategies:*

- Monitor bald eagle nest sites.

- Assist with banding activities as directed.

- Establish an inventory protocol for neotropical migratory songbirds within five years of hiring a biologist.

- Develop and implement an inventory plan for neotropical migratory songbirds and raptors within five years of hiring a biologist.

- Cooperate with other agencies, universities, and organizations performing studies and investigations on the refuge.

**Objective 4: Mammals**
Document the diversity and population of mammals.

Discussion: This alternative only provides for limited surveys of deer and documentation of the presence of mammals. As funds from grants become available or partners express an interest in conducting research on the refuge, they would perform more intensive surveys.

There are mammals on the refuge that provide the prey base for other mammals and birds of prey and the basis for hunting and wildlife observation and photography. There is no database documenting the diversity or population of the species on the refuge, or the effect of management on the species.

*Strategies:*

- Monitor, collect data from, and manage white-tailed deer populations.

- Conduct abomasal parasite count counts every six years.

- Document the presence of mammals as they are identified.

- Cooperate with other agencies, universities, and organizations performing studies and investigations on the refuge.

**Objective 5: Reptiles and Amphibians**
Document the diversity and populations of reptiles and amphibians.

Discussion: This alternative does not provide for surveys of reptiles and amphibians, but does provide for documentation of the presence of reptiles and amphibians. As funds from grants become available or partners express an interest in conducting research on the refuge, they would perform more intensive surveys.

There are reptiles and amphibians on the refuge that provide the prey base for other reptiles and amphibians, mammals, wading birds, birds of prey, and fish. There is no database documenting the diversity or population of the species on the refuge, or the effect of management on the species.

*Strategies:*

- Document the presence of reptiles and amphibians as they are identified.
- Cooperate with other agencies, universities, and organizations performing studies and investigations on the refuge.

**Objective 6: Shorebirds**
Document the diversity and populations of shorebirds.

Discussion: This alternative provides for limited surveys of shorebirds. As funds from grants become available or partners express an interest in conducting research on the refuge, they would perform more intensive surveys.

*Strategies:*

- Conduct limited surveys during peak migration months (April, May, July, August) as time allows.
- Assist with studies and investigations as requested.
- Cooperate with other agencies, universities, and organizations performing studies and investigations on the refuge.

**Objective 7: Wading Birds and Marshbirds**
Document the diversity and populations of wading birds and marshbirds.

Discussion: This alternative provides for systematic surveys of wading birds and marshbirds. As funds from grants become available or partners express an interest in conducting research on the refuge, they would perform more intensive surveys.

*Strategies:*

- Conduct surveys in conjunction with shorebird surveys.
- Note wading bird rookeries as observed.
- Assist with studies and investigations as requested.
- Cooperate with other agencies, universities, and organizations performing studies and investigations on the refuge.

**Objective 8: Waterfowl**
Document the diversity and populations of waterfowl. Monitor wood duck boxes and band wood ducks.

Discussion: This alternative provides for surveys of wintering waterfowl and existing wood duck boxes. It also provides for the banding of waterfowl and resident Canada geese. As funds from grants become available or partners express an interest in conducting research on the refuge, they would perform more intensive surveys.

*Strategies:*

- Monitor wintering waterfowl populations by conducting six bi-weekly aerial surveys and six bi-weekly ground surveys throughout the wintering waterfowl season. Coordinate monitoring with other refuges in the Roanoke-Tar-Neuse-Cape Fear ecosystem and submit data to the coordinated waterfowl website.

- Check up to 120 wood duck boxes for productivity annually.

- Band 100 wood ducks between July 15 and September 10 and other breeding waterfowl as requested.

- Conduct or assist with the banding of wintering waterfowl when requested.

- Monitor and conduct banding of resident Canada geese.

- Assist with studies as requested.

- Cooperate with other agencies, universities, and organizations performing studies and investigations on the refuge.

*GOAL 2. HABITATS*

**Objective 1: All Habitats**
Manage habitats to improve conditions for target species using water management techniques and prescribed fire.

Discussion: This alternative provides for management of natural marshes and forests with fire and managed wetlands (moist-soil units) by fluctuating water levels to achieve the desired effects. It also provides for the development of an overall Habitat Management Plan.

*Strategies:*

- Implement Water Management and Fire Management plans.

- Develop annual Water Management Plan.

- Revise Fire Management Plan annually.

- Develop an overall Habitat Management Plan within five years of hiring a biologist.

**Objective 2: Coastal Fringe Evergreen Forest**
Protect 1,515 acres of healthy, functional coastal fringe evergreen forest habitat to maintain it as a natural community.

Discussion: This alternative provides for only the protection of the habitat. There would be no inventories or management of the habitat.

*Strategies:*

- Control wildfires on the refuge.
- Monitor populations of southern pine beetle every five years.
- Monitor gypsy moth populations annually in cooperation with the North Carolina Forest Service and U.S. Forest Service.
- Cooperate with other agencies to control outbreaks of pest species.

**Objective 3: Mesic Pine Flatwoods**
Protect 131 acres of healthy, functional mesic pine flatwoods forest habitat to maintain it as a natural community.

Discussion: This alternative provides for the protection and management of the habitat with prescribed burning to encourage an herbaceous understory and thinning to manage the canopy.

*Strategies:*

- Control wildfires on the refuge.
- Conduct prescribed burning according to the Fire Management Plan.
- Monitor the vegetation and assess the effects of fire on vegetation within ten years of hiring a biologist.
- Adapt Fire Management Plan according to results of monitoring.
- Monitor gypsy moth populations annually in cooperation with the North Carolina Forest Service.

**Objective 4: Brackish Marsh/Wet Meadow**
Protect 4,251 acres of healthy, functional brackish marsh/wet meadow habitats to maintain them as natural communities. Protect adjacent areas by managing wildfires.

Discussion: This alternative provides for protection of the habitat and management by using prescribed fire. It also provides for monitoring vegetation, geese, and nutria and assessment of the effects of fire, geese, and nutria on vegetation.

*Strategies:*

- Control wildfires on the refuge.
- Conduct prescribed burning according to the Fire Management Plan.
- Manage to provide breeding habitat for secretive marshbirds.
- Monitor the vegetation and assess the effects of fire on vegetation within ten years of hiring a biologist.

- Adapt Fire Management Plan according to results of monitoring.

- Monitor the use of vegetation by geese and nutria within five years of hiring a biologist.

**Objective 5: Roads and Administrative Areas**
Maintain 220 acres (9.2 miles) of roads for public, administrative, and fire access.

Discussion: This alternative provides for the maintenance of roads and administrative areas to service standards.

*Strategies:*

- Provide maintenance of roads to Service standards to assure passable condition.

- Maintain administrative areas in a functional, environmentally sound manner.

**Objective 6: Moist-Soil Units (Managed Wetlands)**
Protect and manage 955 acres of impoundments to provide wintering habitat for migratory waterfowl, shorebirds, wading birds, and land birds, and breeding habitat for marsh birds and land birds.

Discussion: This alternative provides for the management of the habitat with a modest monitoring frequency and modest mudflat goal in the spring and fall.

*Strategies:*

- Manage units according to the Water Management Plan using natural water sources and a well and pump.

- Manage the units to achieve a 50 percent cover of plants rated as good every year.

- Monitor moist-soil vegetation once every three years.

- Manage the units to provide 20 percent of the acreage in mudflats during the peak of spring shorebird migration (May).

- Manage the units to provide 10 percent of the acreage in mudflats during the peak of fall shorebird migration (August).

**Objective 7: Wood Duck Boxes**
Maintain up to 120 wood duck boxes annually in the appropriate habitat.

Discussion: This alternative only provides for the maintenance of 120 wood duck boxes currently erected on the refuge. It also provides for adaptive management in response to dump nesting.

*Strategies:*

- Check and repair up to 120 wood duck boxes annually.
- Document nesting success of up to 120 wood duck boxes annually.
- Erect new boxes as nest box use approaches 60 percent.

**Objective 8: Firebreaks**
Maintain 10 acres (3.0 miles) of firebreaks to facilitate wildfire suppression and provide early successional habitat for wildlife.

Discussion: This alternative provides for the maintenance of firebreaks to Service standards and the clearing of new firebreaks to facilitate wildfire suppression or prescribed burning.

*Strategies:*

- Maintain firebreaks in an effective, environmentally sound manner.
- Clear new firebreaks in an effective, environmentally sound manner.

**Objective 9: Cropland**
Manage 298 acres of cropland to provide a variety of habitats for wintering waterfowl, migratory landbirds, and resident wildlife.

Discussion: This alternative only provides the maintenance of a variety of habitats in refuge croplands. Annual modifications of cropland management will dictate the acreage and location of various habitats. In general, these will include 120 acres maintained for crop production, 50 acres for winter wheat browse, 120 acres maintained in grasslands, and 10 acres maintained as hardwood regeneration. This alternative encourages the development of agreements to provide grain for wildlife consumption off refuge lands.

*Strategies:*

- Utilize the cooperative farming program to provide crops for resident wildlife and browse for migratory waterfowl.
- Ensure that the cooperative farmer manages the cropland in accordance with the Cropland Management Plan.
- Reforest selected cropland by planting and managing hardwoods.
- Maintain grasslands for migratory land birds and resident wildlife.
- Utilize the cooperative waterfowl sanctuary program on private lands with the North Carolina Wildlife Resources Commission as available.

*GOAL 2: PUBLIC USE*

**Objective 1: Hunting**
Provide 600 annual quality opportunities for hunting deer with shotguns, muzzleloading shotguns, rifles, and bows.

Discussion: The refuge has a deer hunting program administered by refuge staff. Refuge regulations are published in a refuge hunting brochure.

*Strategies:*

- Maintain an area for disabled hunters.
- Revise refuge hunting brochure annually.
- Host annual hunter safety course conducted by the North Carolina Wildlife Resources Commission.
- Maintain special hunting information exhibit and regulatory signs.

**Objective 2: Fishing**
Provide fishing opportunities for 20,000 visits annually.

Discussion: Fishing at the refuge occurs on the shorelines of the river, bays, and sounds; banks of canals and impoundments; and a disabled fishing pier. This alternative adds a National Fishing Week event.

*Strategies:*

- Host a youth fishing rodeo.
- Maintain a fishing pier accessible to disabled visitors.
- Maintain a boat ramp on Mackay Island Road.
- Maintain current posted fishing regulations continuously.
- Host a National Fishing Week Event annually within ten years.

**Objective 3: Environmental Education**
Provide environmental education opportunities for up to 350 people annually.

Discussion: This alternative provides for additional environmental education opportunities by request and more planned opportunities. It provides for the coordination, planning, and equipment to carry out those opportunities.

*Strategies:*

- Provide up to eight environmental education programs by request annually.
- Provide eight planned environmental education programs at an outdoor education facility annually.
- Utilize partners and volunteers to conduct education opportunities.
- Equip and develop displays for an environmental education center within five years of hiring an outdoor recreation planner.
- Develop an environmental education plan for the environmental education center within ten years of hiring an outdoor recreation planner.

**Objective 4: Interpretation**
Provide interpretation opportunities for 10,000 visitors annually.

Discussion: This alternative provides for an extensive interpretation program. This alternative provides for the construction of another kiosk and trail and maintenance of seven kiosks and two interpretive trails. The staff would maintain four brochures. The refuge would update panels for the kiosks as needed and maintain three exhibits in the visitor contact station. The refuge would conduct twenty tours annually.

*Strategies:*

- Maintain seven information kiosks and the exhibits in the kiosks as needed.
- Design and construct a seventh information kiosk.
- Develop a cultural resource interpretive site at the former residence of Joseph P. Knapp within five years.
- Revise the refuge brochure every five years.
- Revise the refuge bird list every five years.
- Maintain the refuge web site.
- Update interpretive panels as needed and maintain three existing exhibits in the Joseph P. Knapp Visitor Contact Station.
- Develop a youth wildlife checklist within five years.
- Develop new interpretative exhibits for the education center within five years.
- Conduct twenty tours annually.

**Objective 5: Wildlife Observation**
Provide wildlife observation opportunities for 90,000 people annually.

Discussion: This alternative provides for a slightly improved wildlife observation program. The staff would maintain an observation platform on the north side of State Route 615, a new platform at the Kitchin Impoundment, one trail on the south side of State Route 615, two trails around the managed wetlands (moist-soil areas), and a new trail around the Kitchin Impoundment. The staff would also maintain a refuge bird list and a new youth wildlife checklist.

*Strategies:*

- Maintain Kuralt Trail observation platform, Great Marsh Loop Trail, Mackay Island Trail, Live Oak Point Trail, and roads to facilitate observation.
- Develop and maintain a new trail around the Kitchin Impoundment within ten years.
- Develop and maintain a new observation platform at the Kitchin Impoundment within ten years.
- Revise the refuge bird list every five years.
- Develop a youth wildlife checklist within ten years.

**Objective 6: Wildlife Photography**
Provide wildlife photography opportunities for 6,000 people annually.

Discussion: This alternative provides for an improved wildlife photography program. The staff would maintain an observation platform on the north side of State Route 615, a new platform at the Kitchin Impoundment, one trail on the south side of State Route 615, two trails around the managed wetlands (moist-soil areas), and a new trail around the Kitchin Impoundment. The staff would also maintain a refuge bird list and a new youth wildlife checklist.

*Strategies:*

- Maintain Kuralt Trail observation platform, Great Marsh Loop Trail, Mackay Island Trail, Live Oak Point Trail, and roads to facilitate observation.
- Develop and maintain a new trail around the Kitchin Impoundment within ten years.
- Develop and maintain a new observation platform at the Kitchin Impoundment within ten years.
- Revise the refuge bird list every five years.
- Evaluate special use permits for professional photographers.
- Install a dedicated wildlife photography blind within five years.

**Objective 7: Access**
Maintain as much public access to the refuge as staffing allows and wildlife tolerates.

Discussion: This alternative would provide the staffing to expand access to the refuge. The public desires more access, particularly on weekends. The refuge manager would schedule staff to provide access every Saturday.

*Strategies:*

- Open the refuge during daylight hours from March 15 to October 15.
- Open the office entrance road and maintain office hours Monday through Friday from 7:30 a.m. until 4:00 p.m., and every Saturday from March 15 until October 15.
- Allow vehicle access on the Mackay Island Road to the dike gate year-round and to the fishing pier for disabled anglers from March 15 until October 15.
- Restrict all access beyond the dike gate and in the marshes and impoundments from October 16 to March 14.

**Objective 8: Outreach**
Provide outreach designed for 250,000 people annually.

*Discussion:* This alternative provides for expanded outreach. The refuge would maintain a web site and refuge brochure. The staff would appear at local fairs and festivals as staffing levels allow. The refuge would publish a quarterly newsletter and more press releases. The staff would attend more outreach events.

*Strategies:*

- Participate in Earth Day events, Career Days, Knotts Island Peach Festival, Knotts Island Waterfowl Festival, Green Sea, Fun Safety and Education Day, and the North Carolina State Fair.
- Maintain the refuge web site and the refuge brochure as the program changes.
- Publish a quarterly newsletter.
- Develop twelve news releases annually.
- Make four presentations to local organizations annually on request.
- Publicize refuge events on local public access television stations.

**Objective 9: Refuge Support**
Work continuously and formally with groups that support the refuge to cultivate their support and inform the groups of the refuge's needs and ways to meet the needs.

Discussion: The refuge works with several groups in the area to promote the refuge and support its activities. One group, the Coastal Wildlife Refuge Society, is a traditional Friends Group that supports the refuge, and assists it in seeking grants, financial contributions, and volunteers. The others are groups that assist in the management of the refuge.

*Strategies:*

- Work with the Coastal Wildlife Refuge Society, Knotts Island Ruritan Club, and Ducks Unlimited.
- Develop a Mackay Island Chapter of the Coastal Wildlife Refuge Society.
- Maintain a sales outlet in the visitor contact station.
- Expand refuge sales outlet to a gift shop in the Environmental Education Center within five years of construction of a new office facility.

**Objective 10: Special Events**
Host five events annually to celebrate national events and give the public an opportunity to see the refuge and meet the staff.

Discussion: The refuge would host an expanded array of special events to provide exposure for the refuge.

*Strategy:*

- Host a Fishing Rodeo, four open roads events, an open house, and one other special event annually.

*GOAL 4: RESOURCE PROTECTION*

**Objective 1: Cultural Resources**
Avoid all impacts to cultural resources.

Discussion: Native Americans once had villages along the North Landing River, Currituck Sound, and Back Bay. The refuge staff refers all proposed projects to the Regional Historic Preservation Officer for review and a determination for further action. The Regional Historic Preservation Officer consults with the State Historic Preservation Office and decides how to proceed on on-site investigations. The refuge staff patrols identified sites as part of its routine law enforcement efforts.

*Strategies:*

- Evaluate all proposed projects and coordinate with the Regional Historic Preservation Officer before beginning a project.
- Protect identified cultural resource sites.

**Objective 2: Interagency Coordination**
Maintain a functional level of coordination with local, state, and federal public agencies and private organizations.

Discussion: The staff coordinates with a wide variety of agencies and organizations to protect the resources on the refuge. The staff conducts much of the coordination through constant communication with local and state law enforcement officials who patrol the area around the refuge. Increased coordination with state biologists, federal biologists, non-governmental organizations, and universities would improve management capability. The staff would conduct more deliberate coordination in meetings to establish rules and regulations and delegate responsibilities. The refuge also maintains close coordination with the Knott's Island Volunteer Fire Department.

This alternative also provides for the development of a memorandum of understanding with the Currituck County Game Commission on waterfowl rest areas.

*Strategies:*

- Communicate informally and formally in 70 meetings each year.
- Review and revise formal cooperative agreements as time allows.
- Coordinate management and public use with the North Carolina Wildlife Resources Commission and the Virginia Division of Game and Inland Fisheries.
- Develop a memorandum of understanding with the Currituck County Game Commission on waterfowl rest areas.

**Objective 3: Land Protection**
Continue to purchase land within the approved acquisition boundary.

Discussion: The refuge currently owns 8,219 acres in fee title. The staff is aware of the owners of the tracts within the boundary, but not in government ownership. The staff maintains contact with the owners and organizations that may assist in securing the land. The staff would post the boundaries of land acquired and inventory the habitat on the land.

*Strategies:*

- Maintain contact with landowners within the approved acquisition boundary.
- Cooperate with the Service's Realty Office to process the land of willing sellers.
- Post the boundaries of newly acquired land.
- Inventory the habitat on newly acquired land.

**Objective 4: Law Enforcement**
Enforce refuge regulations and implement a law enforcement outreach program.

Discussion: The refuge staff enforces regulations with a full-time park ranger (law enforcement) and a dual function officer. The park ranger patrols Mackay Island National Wildlife Refuge, as well as Currituck National Wildlife Refuge. The dual function officer patrols the two refuges as his other duties allow and as activity on the refuge dictates. The staff coordinates with cooperating local, state, and federal agencies to enforce regulations on the refuge. This alternative provides for an outreach program to make visitors aware of refuge regulations.

*Strategies:*

- Enforce refuge regulations as time permits.
- Provide assistance to and coordinate with appropriate local, state, and federal law enforcement agencies to facilitate compliance with local, state, and federal law as time permits.
- Develop and install new signs to inform the public of refuge regulations.
- Develop and publish new brochures to inform the public of refuge regulations.

**Objective 5: Navigable Waters**
Consult with the State of North Carolina, the State of Virginia, and the Currituck County Game Commission to establish a cooperative management agreement to regulate certain activities within selected waters.

Discussion: This objective pursues the agreement more pro-actively than the status quo. There are properties that are being impacted by activities on waters that directly affect refuge lands. There are incompatible activities that occur on these waters that threaten refuge habitat and fish and wildlife populations. The States of North Carolina and Virginia have limited resources to enforce existing regulations on those waters. Under this alternative, the Service would actively pursue co-management of those waters. The refuge will also continue to work cooperatively with Currituck County Game Commission to establish prudent rest areas and designated waterfowl hunting blind locations within areas of Currituck County.

*Strategy:*

- Coordinate selection of waters with the Service's coordinating refuge manager.

**Objective 6: Permits**
Limit impacts to refuge resources by evaluating and enforcing special use permits.

Discussion: The refuge staff allows uses of the refuge by reviewing requests for special use permits and permitting some uses subject to conditions. Those uses must be compatible with the mission of the Fish and Wildlife Service, the purpose of the refuge, and the other priority public uses on the refuge. The conditions may restrict the use by limiting the area or season of the activity, the number of individuals participating in the activity, and the access to the refuge for the activity. The conditions may also limit the activity to a degree of habitat or wildlife disturbance that the refuge staff must monitor. This alternative provides for the development of standardized special use conditions and monitoring of compliance with permit conditions.

*Strategies:*

- Evaluate approximately twelve use proposals per year on a case-by-case basis.
- Protect refuge resources by developing special conditions for those permitted uses that are compatible.
- Develop standardized special conditions where possible.

- Monitor permitted activities to ensure compliance and assess the effect of the use on the environment.

**Objective 7: Pest Animals**
Limit impacts to refuge resources by monitoring, controlling, or eradicating pest animals according to a nuisance animal control plan.

Discussion: The refuge staff currently only controls pest animals when the impacts of pest animals are obvious. Animals, such as nutria, may have an impact on habitat and other species, but the Service does not currently staff or fund the refuge to investigate that impact. This alternative provides for development of a nuisance animal control plan, and monitoring and control according to the plan.

*Strategies:*

- Develop an Exotic Plant and Animal Control Plan within five years of hiring a biologist.
- Observe damage to refuge resources and note the locations so staff can monitor according to the plan.
- Control pest animals when they reach threshold levels identified in the plan.

**Objective 8: Pest Plants**
Improve plant communities and limit impacts to refuge resources from pest plants.

Discussion: The staff currently monitors pest plants such as common reed (*Phragmites australis*), alligatorweed (*Alternanthera philoxeroides*), fleabane (*Erigeron annuus*), and johnsongrass (*Sorghum halpense*). Control of pest plants currently depends on the availability of staff and funds. This alternative provides for development of an Exotic Plant and Animal Control Plan, and monitoring and control according to the plan.

*Strategies:*

- Develop an Exotic Plant and Animal Control Plan within five years of hiring a biologist.
- Observe damage to refuge resources and note the locations so staff can monitor according to the plan.
- Control pest plants and animals when they reach threshold levels identified in the plan.

**Objective 9: Significant Natural Heritage Areas**
Limit impacts to the area to retain the natural character of the area.

Discussion: Much of the refuge is a significant state natural heritage area in North Carolina. The refuge manages the area to retain the natural character of the area to fulfill the purpose of the refuge, as well as meet the goals of the state natural heritage program. The refuge Fire Management Plan currently prescribes burning the brackish marsh and coastal fringe evergreen forest to maintain plant diversity. This alternative would implement the same strategies as Alternative 1, but provides for the hiring of a prescribed fire specialist to coordinate the implementation.

*Strategies:*

- Implement the prescribed burning program to mimic the natural fire cycle.
- Monitor the effects of prescribed burning on the area.
- Review and update the Fire Management Plan based on the results of prescribed burning on the refuge.

**Objective 10: Water Quality**
Monitor water quality to assist the staff to minimize impacts to natural resources on and off the refuge.

Discussion: Permits granted for the construction of the Kitchin Impoundment mandate water quality monitoring as mitigation. This alternative provides for additional monitoring on the refuge.

*Strategies:*

- Monitor water quality in the Kitchin Impoundment until 2008.
- Monitor water quality in impoundments, canals, and at pump stations quarterly when a biologist is hired.
- Cooperate with other agencies and organizations performing water quality sampling on the refuge.

**Objective 11: Wilderness Areas**
There are no candidate or designated wilderness areas on the refuge.

Discussion: There are no areas on the refuge of over 5,000 acres without roads dissecting the areas. Mechanized travel through the marshes is required to provide fire protection and track down fire lines for prescribed fire.

**Objective 12. Wildlife Disease Control and Prevention**
Limit impacts to refuge resources from wildlife disease.

Discussion: The refuge staff casually observes wildlife on the refuge for signs of disease and would cooperate with any organized efforts to monitor and control disease.

*Strategy:*

- Coordinate with local, state, and federal agencies as necessary to monitor and control wildlife disease.

*GOAL 5: REFUGE ADMINISTRATION*

**Objective 1: Capital Property Management**
Use increased levels of funding and staff to acquire, operate, effectively maintain, and dispose of capitalized and non-capitalized property.

Discussion: Under this alternative, the staff would perform a level of property management required for effective utilization of the property. This alternative provides for the acquisition and maintenance of recordkeeping to support the refuge purpose.

*Strategies:*

- Acquire minimum equipment necessary to support refuge programs.
- Conduct one capital property inventory and one non-capitalized property inventory annually.
- Maintain adequate administrative records on capital and non-capitalized property.
- Evaluate the operating condition of capital property.
- Maintain and upgrade capital and non-capital property to ensure safety of the staff and the general public.

**Objective 2: Financial Management**
Manage budget efficiently and provide accountability for funds.

Discussion: Financial management affects every aspect of refuge operation. Funding refuge operations is dependent on effective budgeting and requests for funds under the Refuge Operation Needs System (RONS) and Maintenance Management System (MMS). Proper administration of financial records is necessary to document proper expenditure of funds.

*Strategies:*

- Prepare annual budget.
- Maintain the Refuge Operation Needs System (RONS) and Maintenance Management System (MMS).
- Administer payroll, travel, purchasing, and contract documents.

**Objective 3: Office and Visitor Center/Environmental Education Center**
Construct a new office building, renovate the existing office into an environmental education center, and operate and maintain the buildings to ensure efficiency of operation, the safety of the staff and the public, and an aesthetically pleasing appearance.

Discussion: The staff performs the minimum level of property management required by the Fish and Wildlife Service Manual. This alternative provides for the construction of an environmental education center to support the enhanced environmental education and interpretation program.

*Strategy:*

- Cooperate with Regional Office engineering and contracting personnel to design and construct a new office and renovate the existing office.

**Objective 4: Personnel Management**
Recruit, hire, and manage staff shared with the Currituck National Wildlife Refuge at adequate levels (16 employees and 15 full-time equivalent positions).

Discussion: The refuge staff performs the minimum level of personnel management required by the Fish and Wildlife Service Manual.

*Strategies:*

- Provide staff professional, technical, and leadership development training as allowable under current funding levels.
- Encourage staff to utilize details to broaden their experiences as workload allows and opportunities arise.
- Evaluate performance continuously; manage performance and conduct in accordance with Service policy.
- Recognize employee performance through the employee incentives program.

**Objective 5: Real Property Management**
Use increased levels of funding and staffing to maintain buildings, grounds, roads, structures, and public use facilities in a clean and acceptable condition that protects the health and safety of the refuge staff and the public.

Discussion: The staff performs real property management at a level that protects health and safety.

*Strategies:*

- Conduct one real property inventory annually.
- Acquire adequate buildings and structures to meet refuge program needs.
- Pursue resolution of boundary disputes.
- Manage all real property according to Service policy.

**Objective 6: Shop Facilities**
Operate and maintain the existing shop workspace and construct new facilities to ensure efficiency of operation, and the comfort and safety of the staff and the public.

Discussion: The staff performs the minimum level of property management required by the Fish and Wildlife Service Manual.

*Strategy:*

- Construct and maintain a new vehicle maintenance shop as funding allows.

**Objective 7: Volunteer Coordination**
Support biological and maintenance programs with 1,000 hours of service from local and college intern volunteers annually.

Discussion: The refuge utilizes volunteers from the community and college interns to support its programs. The volunteers assist the staff in all phases of operation from routine maintenance to outreach to wildlife and habitat inventories. The staff recruits volunteer interns from colleges, provides housing, and a stipend with which to purchase meals. The staff manages volunteers as required by the Fish and Wildlife Service Manual. This alternative provides for the designation of a volunteer coordinator and sets a larger goal for volunteer service.

*Strategies:*

Recruit, train, and coordinate volunteers to donate 1,000 hours of service annually.

- Expand college intern program.
- Designate a staff member as part-time volunteer coordinator.

# V. Plan Implementation

## INTRODUCTION

The Service will implement utilizing existing staff, facilities, and equipment and acquiring additional staff, facilities, and equipment. The tables below outline the strategies from Chapter IV and list the existing and new staff, facilities, and equipment required to implement the strategies. Appendix VIII contains details of the new staff, facilities, and equipment as Refuge Operation Needs System (RONS) projects or Maintenance Management System (MMS) projects. The appendix also includes the priorities of those projects. The staff will implement the strategies associated with specific projects as the Service funds those projects.

## PROPOSED PROJECTS

**Table 18. Projects supporting wildlife strategies.**

| **Personnel Projects** | |
|---|---|
| **Strategy** | **Projects** |
| Conduct surveys, monitoring, studies, and investigations. | Utilize existing assistant manager and forestry technician.<br>Recruit, hire, and train new wildlife biologist (RONS 97006) and biological technician (RONS 00013). |
| Encourage universities, other agencies, and organizations to conduct surveys, monitoring, studies, and investigations. | Utilize existing manager and assistant manager.<br>Recruit, hire, and train new wildlife biologist (RONS 97006). |
| Administer public hunts to manage deer population. | Utilize existing manager, assistant manager, and law enforcement officer. |
| Protect wildlife. | Utilize existing law enforcement officer. |
| Manage budget, contracts, personnel, and property. | Utilize existing refuge manager, assistant manager, and office assistant.<br>Recruit, hire, and train new clerk (RONS 99004). |
| Apply for flexible fund and other grants. | Utilize existing manager and assistant manager.<br>Recruit, hire, and train new wildlife biologist (RONS 97006). |
| **Equipment Projects** | |
| Replace equipment to survey and protect wildlife. | Replace equipment (various MMS projects). |

**Table 19. Projects supporting habitat strategies.**

| Personnel Projects | |
|---|---|
| **Strategy** | **Projects** |
| Conduct surveys, monitoring, studies, and investigations.<br>Develop annual burn and water management plans. | Utilize existing assistant manager and forestry technician.<br>Recruit, hire, and train new wildlife biologist (RONS 97006) and biological technician (RONS 00013). |
| Conduct prescribed burning. | Utilize existing assistant manager, forestry technician, engineering equipment operators, and maintenance workers.<br>Recruit, hire, and train new fire management specialist (RONS 00009). |
| Protect habitat. | Utilize existing law enforcement officer. |
| Manage budget, contracts, personnel, and property. Manage refuge Operation Needs System (RONS), Maintenance Management System (MMS), Real Property Inventory (RPI), and Service Asset Maintenance management System (SAMMS). | Utilize existing refuge manager, assistant manager, and office assistant.<br>Recruit, hire, and train new clerk (RONS 99004) |
| Apply for flexible fund and other grants. | Utilize existing manager and assistant manager.<br>Recruit, hire, and train new wildlife biologist (RONS 97006). |
| **Equipment Projects** | |
| Replace equipment to manage habitat. | Replace equipment (various MMS projects). |
| **Facility Projects** | |
| Replace facilities to manage habitat. | Replace bulkheads, water control structures, and pumping stations (various MMS projects). |

## REFUGE ADMINISTRAION

The Fish and Wildlife Service administers Mackay Island National Wildlife Refuge located on Knotts Island along the North Landing River. The staff administers 8,219 acres of fee title land of the Mackay Island National Wildlife Refuge in Currituck County, North Carolina, and Virginia Beach, Virginia, and 4,383 acres of the fee title land and 3,931 acres of conservation easement land at the Currituck National Wildlife Refuge on the Outer Banks of Currituck County, North Carolina. The marshes on the western edge of Currituck National Wildlife Refuge are located six miles east of the Mackay Island Refuge headquarters across the Currituck Sound. The western marshes are one-half mile east of the boat ramp on Knotts Island Bay; the upland portion of the refuge is two miles east of the boat ramp. It is 100 miles and almost a 3-hour drive to the Currituck National Wildlife Refuge around the Sound by roads (Figure 1).

**Table 20. Projects supporting public use strategies.**

| Personnel Projects | |
|---|---|
| **Strategy** | **Projects** |
| Plan, design, and conduct programs and outreach. | Utilize existing assistant manager.<br>Recruit, hire, and train new outdoor recreation planner (RONS 97013). |
| Maintain education, interpretation, wildlife observation, and photography facilities. | Utilize existing engineering equipment operator and maintenance worker.<br>Recruit, hire, and train new maintenance worker (RONS 00019). |
| Protect visitors. | Utilize existing manager and law enforcement officer. |
| Manage budget, contracts, personnel, and property. | Utilize existing refuge manager, assistant manager, and office assistant.<br>Recruit, hire, and train new clerk (RONS 99004) |
| Apply for flexible fund and other grants. | Utilize existing refuge manager and assistant manager. |
| **Equipment Projects** | |
| Replace equipment to maintain facilities as necessary. | Replace equipment (various MMS projects). |
| **Facility Projects** | |
| Replace facilities as necessary. | Replace and rehabilitate roads, parking lots, kiosks, facilities for observation and photography, office, shop, garage, and residence (various MMS projects). |

The maintenance and operation of the refuge's administrative facilities will continue, regardless of how quickly the Service implements the plan. Periodic upgrading of facilities is necessary for safety and accessibility and to support staff and management needs. The staff has identified funding and staffing needs for several projects, including additional facilities and equipment to support refuge operation and maintenance.

## FUNDING AND PERSONNEL

Currently the Service has approved a staff of six (6.0 full-time equivalents) permanent positions for the refuge. There is also one (1.0 full-time equivalent) other position funded for fire management headquartered at the refuge. The plan proposes to increase the staff to fifteen, thirteen non-fire and two fire employees. Two of the positions, an assistant manager and a biological technician, would be headquartered at the Currituck National Wildlife Refuge, but would be supervised by the manager at Mackay Island Refuge.

**Table 21. Projects supporting resource protection.**

| Personnel Projects | |
|---|---|
| **Strategy** | **Projects** |
| Maintain cooperation with agencies, organizations, and permit holders.<br>Review permits and develop conditions for uses allowed by permits.<br>Maintain contact with owners of property within acquisition boundary. | Utilize existing refuge manager and assistant manager. |
| Protect cultural resources. | Utilize existing refuge manager, assistant manager, and law enforcement officer. |
| Protect areas from wildfire; implement prescribed fire plan to manage fuel. | Utilize existing forestry technician.<br>Recruit, hire, and train a fire management specialist (RONS 00009). |
| Monitor pest animals and plants and permitted uses. | Utilize existing assistant manager.<br>Recruit, hire, and train new wildlife biologist (RONS 97006) and biological technician (RONS 00013). |
| Maintain equipment and facilities. | Utilize existing engineering equipment operator and maintenance worker.<br>Recruit, hire, and train new maintenance worker (RONS 00019). |
| Enforce regulations. | Utilize existing law enforcement officer. |
| Manage budget, contracts, personnel, and property. | Utilize existing refuge manager, assistant manager, and office assistant.<br>Recruit, hire, and train new clerk (RONS 99004) |
| Apply for flexible fund and other grants. | Utilize existing refuge manager and assistant manager. |
| **Equipment Projects** | |
| Replace equipment as necessary. | Replace equipment (various MMS projects). |
| **Facility Projects** | |
| Replace facilities as necessary. | Replace and rehabilitate roads, parking lots, kiosks, water control structures, pumps, shop, garage, and office (various MMS projects). |

**Table 22. Projects supporting refuge administration strategies.**

| Personnel Projects | |
|---|---|
| **Strategy** | **Projects** |
| Manage budget, contracts, personnel, and property; process payroll and travel vouchers; maintain RONS AND MMS. | Existing refuge manager, assistant manager, office assistant.<br>New office assistant (RONS 99004). |
| Maintain equipment and facilities. | Existing engineering equipment operator and maintenance worker.<br>New maintenance worker (RONS 00019). |
| **Budget Projects** | |
| | |
| **Equipment Projects** | |
| Replace equipment as necessary. | Replace equipment (various MMS projects). |
| **Facility Projects** | |
| Replace, rehabilitate, and construct facilities as necessary. | Replace bulkheads, water control structures, pumping stations, parking lots, kiosks, office, shop, garage, and residence; rehabilitate roads (various MMS projects). |

To complete the extensive wildlife habitat management and restoration projects and conduct the necessary inventorying, monitoring, and mapping activities, the refuge requires more staff. The proposed staffing plan (Table 23) would enable the refuge to achieve its plan objectives and strategies within a reasonable time. The annual cost (including salaries and benefits) would be $493,600. The rate at which this refuge realizes its full potential to contribute locally, regionally, and nationally to wildlife conservation and appropriate wildlife-dependent recreation and environmental education is totally dependent upon receiving adequate staffing and funding.

## VOLUNTEERS

The refuge currently uses 1,000 hours of volunteer service annually. College interns contribute the majority of the volunteer service. The interns reside on the refuge and receive a stipend for their meals. There are limited opportunities for recruitment from the community. The plan projects to maintain the volunteer service of 1,000 hours by recruiting college interns and volunteers from the community.

## PARTNERSHIP OPPORTUNITIES

A major objective of this comprehensive conservation plan is to establish partnerships with local volunteers, landowners, private organizations, and state and federal natural resource agencies. In the immediate vicinity of the refuge, opportunities exist to establish partnerships with sporting clubs, elementary and secondary schools, and community organizations. At regional and state levels, the Service might establish partnerships with organizations such as the North Carolina Wildlife Resources Commission, Virginia Department of Game and Inland Fisheries, North Carolina Division of Marine Fisheries, The Nature Conservancy, Ducks Unlimited, and National Audubon Society.

The refuge volunteer program and other partnerships generated would depend upon the number of staff positions the Service provides the refuge. As the Service commits staff and resources to the refuge, the refuge will take the opportunities to expand the volunteer program and develop partnerships.

**Table 23. Proposed staff of Mackay Island and Currituck National Wildlife Refuges – 2005.**

| Position | Status | Percent of Time on Mackay Island |
|---|---|---|
| **Management Staff** | | |
| Refuge Manager, GS-0485-13* | PFT | 55 |
| Assistant Manager, GS-0485-09* | PFT | 65 |
| Assistant Manager, GS-0485-09** (Currituck) | PFT | 95 |
| Park Ranger (Law Enforcement), GS-0026-09* | PFT | 25 |
| Office Assistant, GS-0303-05* | PFT | 85 |
| Office Automation Clerk, GS-0303-04** | PFT | 55 |
| **Biological Staff** | | |
| Wildlife Biologist, GS-0486-09** | PFT | 65 |
| Biological Technician, GS-07** | PFT | 55 |
| Biological Technician, GS-07** (Currituck) | PFT | 10 |
| **Public Use Staff** | | |
| Park Ranger, GS-0026-09** | PFT | 40 |
| **Maintenance Staff** | | |
| Maintenance Mechanic, WG-4749-10* | PFT | 85 |
| Engineering Equipment Operator, WG-5716-08* | PFT | 60 |
| Maintenance Worker, WG-4749-08 ** | PFT | 55 |
| **Fire Management Staff** | | |
| Forestry Technician, GS-0462-05 (Fire)* | PFT | 60 |
| Fire Management Specialist, GS-0401-09 (Fire)** | PFT | 60 |

*PFT = permanent full time, TFT = temporary full time, Fire = Funded by Fire Budget*
** = current staff, ** = staff added by plan*

## STEP-DOWN MANAGEMENT PLANS

A comprehensive conservation plan is a strategic plan that guides the direction of the refuge. Before the refuge staff can implement some of the strategies and projects, it must prepare or update detailed step-down management plans. To assist in preparing and implementing the step-down plans, the staff will develop partnerships with local agencies and organizations. The Service will develop the plans (Table 24) in accordance with the National Environmental Policy Act, which requires the identification and evaluation of alternatives and public review and involvement prior to their implementation.

Habitat Management Plan (Develop), Draft Completion -12 years after hiring a biologist. This plan will describe the overall desired habitat conditions needed to fulfill refuge purpose and objectives. The plan will include three sections dealing with moist-soil/water management units, forests, and croplands. The staff will develop the procedures, techniques, and timetables for achieving desired future conditions into an overall plan.

Moist-Soil/Water Management Plan (Update), Draft Completion – 2006. This plan will describe the strategies and procedures (timing and duration of flooding and disturbance) for manipulating the refuge's water management units to meet habitat management objectives.

Forest Management Plan (Develop), Draft Completion – when contract is funded. This plan will describe strategies for meeting forest management objectives. It will include direction on reforestation, stand improvement, and harvest. Also, the plan will address scrub/shrub habitat management.

Fire Management Plan (Update), Draft Completion – 2002. This plan will describe wild and prescribed fire management techniques that the refuge will employ. Wildfire control descriptions will include initial attack strategies and cooperative agreements with other agencies.

**Table 24. Mackay Island National Wildlife Refuge step-down management plans.**

| PLAN | COMPLETION DATE |
|---|---|
| Habitat Management | 12 Years after Hiring a Biologist |
| Moist-Soil Management | 2006 |
| Forest Management | When Funded |
| Fire Management | 2002 |
| Wildlife Inventory | 5 Years after Hiring a Biologist |
| Integrated Pest Management | 10 Years after Hiring a Biologist |
| Nuisance Animal Control | 10 Years after Hiring a Biologist |
| Exotic Plant Control | 5 Years after Hiring a Biologist |
| Visitor Services | 5 Years after Hiring a Outdoor Recreation Planner |
| Environmental Education | 5 Years after Hiring a Outdoor Recreation Planner |
| Fishing | 2005 |
| Hunting | 2005 |
| Sign | 2005 |
| Law Enforcement | 2005 |

Biological Inventory/Monitoring Plan (Develop), Draft Completion – 10 years after hiring a biologist. This plan will describe inventory and monitoring techniques and time frames. The staff will inventory all plant communities and associations in the refuge as well as all trust species (migratory birds, including songbirds, neotropical passerines, and waterfowl), listed species (federal and state threatened, endangered and species of concern), and key resident species, and monitor population trends. These data are essential to guide wildlife habitat management.

Integrated Pest Management Plan (Develop and Update), Draft Completion – 10 years after hiring a biologist. This plan will address the complex issue of bringing exotic and nuisance plants and animals to a maintenance control level on the refuge. It will cover chemical pesticide use (aerial and ground application), mechanical eradication, and biological controls. The nuisance/exotic animal and plant control plans will be sections of this plan.

Nuisance/Exotic Animal Control Plan (Update), Draft Completion – 10 years after hiring a biologist. This plan (as part of the Integrated Pest Management Plan) will describe survey, removal or control, and monitoring techniques for both terrestrial and aquatic nuisance and exotic animals (vertebrate and invertebrate). This plan will include nutria, mink, and feral dog control.

Nuisance/Exotic Plant Control Plan (Develop), Draft Completion – 5 years after hiring a biologist. This plan (as part of the Integrated Pest Management Plan) will describe survey, removal or control, and monitoring techniques for both terrestrial and aquatic nuisance and exotic plants.

Visitor Services Plan (Develop), Draft Completion – 5 years after hiring an outdoor recreation planner. This plan will describe the refuge's wildlife-dependent recreation, environmental education, and interpretation programs. It will address specific issues or items, such as facility requirements, site plans, and handicapped accessibility. The environmental education, fishing, hunting, and sign plans will be sections of this plan.

Environmental Education Plan *(*Develop), Draft Completion – 5 years after hiring an outdoor recreation planner. This plan will reflect the objectives and strategies of the comprehensive conservation plan and address environmental education guidelines following Service standards.

Fishing Plan (Update), Draft Completion 2005. This plan (as part of the Visitor Services Plan) will address specific aspects of the refuge's fishing program. It will define fishing areas, methods, handicapped accessibility, facilities needed, and refuge-specific regulations.

Hunting Plan (Update), Draft Completion 2005. This plan (as part of the Visitor Services Plan) will address specific aspects of the refuge's hunting program. It will define species to be hunted, season structures, hunt areas, methods, all-terrain vehicle use, handicapped accessibility, facilities needed, and refuge-specific hunting regulations.

Sign Plan (Update), Draft Completion 2005. This plan (as part of the Visitor Services Plan) will describe the refuge's strategy for informing visitors via signage. It will incorporate Service guidelines.

Law Enforcement Plan (Update), Draft Completion 2005. This plan will provide a reference to station policies, procedures, priorities, and programs concerning law enforcement.

## MONITORING AND ADAPTIVE MANAGEMENT

Adaptive management is a flexible approach to long-term management of biotic resources under which the staff utilizes the results of ongoing monitoring activities and other information to evaluate and change practices. More specifically, adaptive management is a process by which projects are implemented within a framework of scientifically driven experiments to test the predictions and assumptions outlined within a plan.

To apply adaptive management, the staff would adopt specific surveying, inventorying, and monitoring protocols for the refuge. They would evaluate habitat management strategies systematically to determine management effects on wildlife populations. They would use the information to refine approaches and determine how effectively the objectives are being accomplished. Evaluations would include ecosystem team and other appropriate partner participation. If monitoring and evaluation indicate undesirable effects for target and non-target species and/or communities, then the refuge would alter management projects. Subsequently, the staff would revise the refuge's comprehensive conservation plan.

The Service would describe specific monitoring and evaluation activities in the step-down management plans.

**SECTION B. DRAFT ENVIRONMENTAL ASSESSMENT**

# *I. Background*

## PURPOSE AND NEED FOR ACTION

The purpose of the environmental assessment for the comprehensive conservation plan is to determine and evaluate a range of reasonable management alternatives for Mackay Island National Wildlife Refuge. The staff generated each alternative with the potential to be fully developed into a final comprehensive conservation plan. The environmental assessment also predicts and evaluates the biological, physical, and socioeconomic effects of implementing each alternative. From this range of alternatives, the staff then identified the proposed management action.

In accordance with the guidelines of the National Environmental Policy Act, the Service identified a number of issues, concerns, and needs through discussions with the public, agency managers, and professionals. From these issues and concerns, the Service's planning team identified a range of four alternatives, evaluated the possible consequences of implementing each, and selected Alternative 2 as the proposed management action. In the opinion of the Service and the planning team, Alternative 2 is the best approach to guide the refuge's management direction.

There is no current plan that identifies priorities and ensures consistent and integrated management for the refuge, thus necessitating the need for this environmental assessment. The National Wildlife Refuge System Improvement Act of 1997 requires that all national wildlife refuges have a comprehensive conservation plan in place within 15 years to help fulfill the mission of the Refuge System.

## DECISIONS FRAMEWORK

Based on this draft environmental assessment, the Fish and Wildlife Service will select an alternative to implement the Comprehensive Conservation Plan for Mackay Island National Wildlife Refuge. The public will have an opportunity to review and comment on the draft plan and environmental assessment. Based on a review of those comments, the Service will determine whether implementation of the plan will have a significant impact on the environment or not. The Service will prepare a Finding of No Significant Impact if the selected alternative will not have a significant impact on the quality of the environment. The Service will prepare an Environmental Impact Statement if the selected alternative will have a significant impact on the quality of the environment. The staff will base this determination on an evaluation of the purposes for which the refuge was established, the missions of the Service and the National Wildlife Refuge System, and other legal mandates. Assuming that no significant impacts are found, implementation of the plan will begin, and the staff will monitor the impacts of the plan on an annual basis and revise it when necessary.

## PLANNING STUDY AREA

Mackay Island National Wildlife Refuge is in northeastern North Carolina and southeastern Virginia just northwest of the confluence of the North Landing River and Currituck Sound and south of Back Bay. The city of Virginia Beach, Virginia, is the nearest major city and extends to the Virginia-North Carolina state line that is one mile north of the refuge's northwest boundary on Princess Anne Road.

The planning study area for this environmental assessment includes lands outside the existing refuge boundary that are being studied for inclusion in the National Wildlife Refuge System and/or partnership planning efforts. The Service presently owns and manages 8,219 acres of the 9,503

acres identified as lying within the refuge's approved acquisition boundary. The Service will seek to acquire, from willing sellers, the remaining acres. This environmental assessment will identify management on existing refuge lands.

## AUTHORITY, LEGAL COMPLIANCE AND COMPATIBILITY

A variety of international treaties, federal laws, and Presidential executive orders guide the administration of Pocosin Lakes National Wildlife Refuge. Appendix III contains the documents and acts that allow the management options under the refuge's establishing authority and the National Wildlife Refuge System Improvement Act of 1997 (the legal and policy guidance for the operation of national wildlife refuges).

The National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, states that the Service must protect National Wildlife Refuges from incompatible or harmful human activities to ensure that Americans enjoy Refuge System lands and waters. Before the Service allows activities or uses on a National Wildlife Refuge, the staff must find the uses to be compatible. A compatible use does not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge. The refuge may authorize wildlife-dependent recreational uses when they are compatible and not inconsistent with public safety.

An interim compatibility determination is a document that assesses the compatibility of an activity during the period of time the Service first acquires a parcel of land to the time a formal, long-term management plan for that parcel is prepared and adopted. The Service has completed an interim compatibility determination for the six priority general public uses of the system, as listed in the National Wildlife Refuge System Improvement Act. These uses are hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation.

## PLANNING PROCESS AND ASSOCIATED ISSUES

Representatives from the Fish and Wildlife Service and state wildlife agency personnel attended initial planning meetings. At these initial meetings, they discussed strategies for completing the plan, identified the staff's issues and concerns, and compiled a mailing list of likely interested government agencies, non-governmental organizations, businesses, and individual citizens. The Service invited these agencies, organizations, businesses, and citizens to participate in four public scoping meetings on June 19, 21, 26, and 28, 2001 in Currituck, North Carolina, Corolla, North Carolina, Virginia Beach, Virginia, and Knotts Island, North Carolina. The Service introduced the attendees to the refuge and its planning process and asked those present to identify any issues and concerns. The Service published announcements giving the location, date, and time for the public meetings in the Federal Register and placed legal notices in local newspapers. Press releases were sent to local newspapers and public service announcements to television and radio stations. Service personnel placed fifty posters announcing the meeting in local post offices, local government buildings, and stores.

The planning teams expanded the issues and concerns to include those generated by the agencies, organizations, businesses, and citizens from the local community. These issues and concerns formed the basis for the development and comparison of the objectives in the different alternatives described in this environmental assessment.

The objectives were subjects of discussion at a second round of public meetings on November 18, 19, 20, and 21, 2002 in Corolla, Currituck, and Knotts Island, North Carolina and Virginia Beach,

Virginia. The Service published announcements giving the location, date, and time for the public meetings as legal notices in local newspapers. Press releases were again sent to local newspapers and public service announcements to television and radio stations. Service personnel placed seventy-five posters announcing the meeting in local post offices, local government buildings, and stores.

*PLAN REVIEW AND REVISION*

The staff will review this comprehensive conservation plan annually to determine the need for revision. A revision would occur if and when major changes in ecological conditions occur or the Service plans a major expansion. The staff will augment the final plan by detailed step-down management plans and annual plans to address the completion of specific strategies in support of the refuge's goals and objectives. Revisions to the comprehensive conservation plan and the step-down management plans would be subject to public review and compliance with the National Environmental Policy Act.

*PLANNING ISSUES AND CONCERNS*

A number of issues and concerns were generated from the input of local citizens and public agencies, the team members' knowledge of the area, and the resource needs identified by the staff and biological review team. A Fish and Wildlife Service planning team was assembled to evaluate the resource needs. The team then developed a list of goals, objectives, and strategies to shape the management of the refuge for the next 15 years.

These issues provided the basis for developing the refuge's alternative management objectives and strategies. These issues played a role in determining the desired future conditions for the refuge and were considered in the preparation of the long-term comprehensive conservation plan. The issues and concerns are described below. They are of local, regional, and national significance and reflect similar issues that were, in part, identified by the public at the planning meetings.

**Hydrology**

*Drainage*

Previous landowners have dug drainage ditches to facilitate crop production and access for hunting. The ditches effectively lower the water table draining subsurface water in the vicinity of the ditch. They also impound water behind the piles of soil excavated from the ditches and allow water from the rivers, bays, and sounds to flow into the wetland on the refuge more rapidly than it would naturally. The drainage affects the plant communities on the refuge by providing habitat for species adapted to better drainage close to the ditches and on the tops of spoil piles. The flooding of areas behind the spoil piles inhibits plant regeneration and favors species that are better adapted to more persistent and frequent flooding than would have occurred naturally. Mackay Island Road and North Carolina Route 615 have also altered historic drainage patterns throughout the marsh.

*GLOBAL WARMING AND SEA LEVEL RISE*

Most of the refuge lies at or within a few feet of sea level. Much of the refuge has a water table within a foot of the soil surface. Marshes cover the majority of the refuge. Wetland forest stands cover most of the balance of the refuge. Scientists predict that the sea level along the North Carolina coast will rise from two to three feet in the next 100 years due to global warming. That rise in water levels will change the types of vegetative cover on the refuge. The grass-dominated marshes that occupy the majority of the refuge will lie below sea level and will become open water areas. The marshes will expand into areas currently covered by forest trees.

As the habitats change, the wildlife species that inhabit those habitats will also change. Wading birds, waterfowl, and marsh birds that use the marshes for cover, feeding, and nesting will loose that kind of habitat. Neotropical migratory songbirds and wood ducks that currently utilize trees will loose their feeding and nesting sites as trees die and fall. The species that utilize the areas that are currently marsh will move upslope as the marshes replace the trees.

**Fish and Wildlife Populations**

*Threatened and Endangered Species*

Recovery and protection of threatened and endangered plants and animals is an important responsibility delegated to the Service and its national wildlife refuges. Three threatened or endangered animals are thought to use (or could use) Mackay Island Refuge: the bald eagle, red-cockaded woodpecker, and West Indian manatee.

Threatened bald eagles nest on Mackay Island Refuge. They also nest in adjacent counties and travel the river corridor and shoreline of the Sound. The refuge's habitat protection and management activities provide suitable habitat for nesting eagles.

Records of the occurrence of endangered red-cockaded woodpeckers in Currituck County are more than twenty years old. There is suitable habitat in the refuge in the coastal fringe evergreen forest. As the forest ages and pine trees develop suitable nesting cavities, the refuge could support woodpeckers. Sustaining viable populations will require proper understory management.

Endangered West Indian manatees are occasionally cited in Currituck County and areas further north, but Currituck County is outside the normal range of the manatee.

*Waterfowl*

The scoping process identified the management of all refuge marshes, managed wetlands (moist-soil units), and forests for waterfowl and expanding waterfowl hunting opportunities as issues. In order to meet the refuge's waterfowl purpose, the refuge must maintain the marsh, forest and managed wetlands (moist-soil units) to meet waterfowl habitat needs and provide sufficient sanctuary areas to provide undisturbed resting and feeding areas for waterfowl. The Service can provide waterfowl hunting opportunities as the refuge acquires additional land outside the proclamation boundary within which the Service prohibits waterfowl hunting. The core waterfowl sanctuary needs to remain intact to meet the undisturbed resting and feeding needs of waterfowl.

The refuge's waterfowl purpose guides all operation and management actions on the refuge. The refuge manages forested wetlands to meet the feeding, resting and breeding needs of migratory and resident waterfowl. Staff of the Fish and Wildlife Service and cooperating agencies and organizations conducted a Biological Review of Mackay Island National Wildlife Refuge in 1999 and 2000, as part of the comprehensive conservation planning process. They identified objectives to meet the minimum water, food, sanctuary, and resting/loafing habitat requirements of waterfowl.

*Neotropical Migratory Birds*

Neotropical migratory birds are a species group of special management concern. Providing habitat (i.e., forest and marshes) for these birds is one of the refuge's major objectives. Strategic forest management compatible with the refuge's waterfowl habitat objectives would contribute to the forest needs of neotropical migratory birds. The Biological Reviews cited in the Waterfowl section above identified objectives needed to meet the minimum feeding and nesting habitat requirements of neotropical migratory birds. The neotropical migratory birds are also a major focus of the refuge wildlife observation program as many birders visit the refuge to observe nesting, feeding, and loafing birds.

**Habitats**

*Brackish Marsh and Managed Wetlands*

Participants at the public scoping meetings held to solicit input to the plan expressed strong support for continued intensive management of the marshes and managed wetlands (moist-soil units) along the North Landing River, Back Bay, and Currituck Sound. They were well aware of the connection between that management, and opportunities for hunting on adjacent lands (primarily for waterfowl).

Mackay Island River National Wildlife Refuge is near several large marshes in the South Atlantic Coastal Plain Physiographic Zone. Cooperative private-state-federal partnerships under the North American Waterfowl Management Plan, Partners-in-Flight, and the Atlantic Coast Joint Venture recommend maintenance and stabilization of the marsh. With strategic management, the staff can provide quality marsh habitat with the proper water management, prescribed burning, and aquatic weed control.

*Forests*

There is public recognition of the role of the refuge's small forest area in white-tailed deer and neotropical migratory bird populations and the public use associated with deer hunting and bird-watching. At the public scoping meetings, the public also expressed an appreciation of the function of the forest in support of the other aspects of the refuge's public use program. The refuge has not developed a management plan for its forestlands, but does treat insect and disease infestations as they occur and conducts prescribed burning as opportunities present themselves. The public encouraged the staff to make forest management a higher priority than it has been. A biological review in 2002 recognized the importance of a forest assessment. The review also found that an active forest management program would be difficult to maintain due to limited forest areas.

**Public Use**

*Visitor Services and Education*

The refuge is in Currituck County, North Carolina (2000 population 18,190), and Virginia Beach, Virginia (2000 population 425,257), within 27 miles of the Virginia Beach business district. There is a need to promote nature-based tourism in northeastern North Carolina in the rural counties that have an abundance of natural resources to attract tourists, but are dominated by wetlands that limit traditional economic development. Virginia Beach attracts three million tourists per year and another 78,000 people drive past the refuge to use the ferry to travel from Knotts Island to Currituck, North Carolina. A few commercial interests guide canoeing and angling adventures. The refuge is an important link to the other natural areas that together make these experiences possible. Carefully selected and managed staff, programs, and facilities will provide the wildlife-dependent environmental education,

interpretation, and recreation opportunities the refuge's visitors expect. The refuge will require additional staff support to achieve the refuge's visitor service potential.

*Hunting*

Hunting is an integral part of rural North Carolina culture. It is not surprising that there is a considerable interest from the state agencies and the local citizens in expanding hunting opportunities. The initial refuge strategy must be maintenance of the quality of hunting at existing levels. Any additional hunting opportunities will be dependent on providing safe, quality experiences that are compatible with refuge purposes. The refuge requires additional law enforcement personnel to administer additional deer hunts. There may be an opportunity to add additional hunting opportunities on the refuge.

*Fishing*

Anglers utilize the refuge ditches, impoundments, a boat ramp on Mackay Island Road, and the handicapped accessible fishing pier for fishing opportunities. The public expressed an interest in improving access to the refuge for fishing. The refuge has the potential to add a boat ramp and expand safe access to bank fishing areas.

*Roads and Trails, Exterior and Interior*

The Service limits access to the office and Kitchin Impoundment to the hours of 7:30 a.m. to 4:00 p.m. Monday through Friday. It limits access to the remainder of the refuge to daylight hours from March 15 to October 15. The public expressed an interest in more access to the refuge. As the refuge adds staff to work weekends, it can consider increasing access to the office area and the remainder of the refuge. The refuge must limit access to areas where bald eagles nest and waterfowl rest and feed when the birds are in the areas to minimize disturbance.

**Resource Protection**

*Cultural Resources*

Local residents, the staff, and the Fish and Wildlife Service in the regional and national office are all aware of the importance of the Mackay Island National Wildlife Refuge as the former home of Joseph P. Knapp, who founded "More Game Birds in America," which later became Ducks Unlimited. Mr. Knapp was a wealthy philanthropist from New York who modernized the education system in Currituck County. Historians widely recognize his legacy in wildlife management and education reform in the county. The public encouraged the refuge staff to continue to interpret Mr. Knapp's contributions to the area.

There are thirteen cemetery plots on the refuge. The staff has noted their locations on maps in the refuge office.

*Land Acquisition and Habitat Fragmentation*

When it was established, the refuge's role in providing managed wetlands (moist-soil units) and brackish marsh was providing additional habitat types for migratory waterfowl. Reevaluation has determined that those habitats are as important for marsh birds and neotropical migratory songbirds (in support of Partners-in-Flight) as they are for waterfowl habitat. The refuge's current acquisition boundary reflects the importance of protecting and managing the most valuable brackish marsh. The Service has identified a few private properties in an internal land protection plan (U.S. Fish and Wildlife Service 1994) that have

value as marsh habitat and cropland for high energy foods for migrating waterfowl, but they are outside the refuge acquisition boundary. Those properties are important links in protecting areas along Back Bay, North Landing River, and Currituck Sound. To maintain the potential to protect these lands, the Service must have the ability and authority to manage and protect (through acquisition of fee title interest or conservation easements) the important habitat beyond the refuge's current acquisition boundary. Also, acquisition of fee title interest in new lands will provide expanded public use opportunities when compatible; conservation easements would not.

*Law Enforcement and Refuge Regulation*

The refuge has enforced the applicable laws and regulations through the use of one full-time law enforcement officer shared with Currituck National Wildlife Refuge and one dual function officer, currently the refuge manager. The use of dual function officers to perform enforcement functions utilizes a great deal of the time they could devote to refuge administration and support of the biological, public use, and maintenance programs. This is particularly evident during hunting season when the law enforcement workload is at its highest. They are limited in their enforcement authority on the Currituck National Wildlife Refuge's easement properties and must rely on state and county law enforcement officers to assist them. They are also limited in the amount of time they can devote to permit monitoring and enforcement of the conditions on the permits.

*Other Resource Protection*

There are other threats to refuge resources that require closer monitoring and management. Pest plants, such a phragmites, and animals, such as nutria, and wildlife disease are all concerns to which the refuge, with adequate personnel and funding, should be paying closer attention.

**General Administration**

*Funding and Staffing*

Funding has been insufficient to support refuge programs. Inadequate staff, facilities, and equipment have prevented the refuge from realizing its purpose and management objectives. Currently, the refuge is not meeting its wildlife habitat objectives beyond moist-soil units. It conducts few wildlife inventories beyond waterfowl; has few public use facilities; has outdated habitat/wildlife management plans; and provides few non-hunting or fishing wildlife-dependent recreational opportunities. The refuge only addresses other priority public uses (environmental education, interpretation, wildlife observation, wildlife photography) as the public requests them. The assistant manager performs the functions of a wildlife biologist and outdoor recreation planner, as well as those for which he/she was hired. The refuge needs additional staff to meet its objectives. The biological and public use programs are currently the greatest needs.

# *II. Affected Environment*

See Refuge Overview, Section A, Chapter II.

# *III. Description of Alternatives*

## FORMULATION OF ALTERNATIVES

Alternatives are different approaches or combinations of management objectives and strategies designed to achieve the refuge purpose, vision, and the goals identified in the comprehensive conservation plan; the priorities and goals of the Roanoke-Tar-Neuse-Cape Fear Ecosystem Team; the goals of the National Wildlife Refuge System; and the mission on the Fish and Wildlife Service. Alternatives are formulated to address the important issues, concerns, and problems identified by the Service and the public during public scoping.

The three alternatives identified and evaluated represent different approaches to provide permanent protection, restoration and management of the refuge's fish, wildlife, plants, habitats, and other resources. A major consideration in the formulation of the alternatives is the ability to obtain sufficient proprietary interest in lands to facilitate a physical and biological connection between habitats, and to restore the functions and values of wetlands.

Refuge managers assessed the biological conditions and analyzed the external relationships affecting the refuge. This information contributed to the development of goals and objectives and, in turn, helped to formulate the alternatives. As a result, each alternative presents different sets of objectives for reaching refuge goals. Each alternative was evaluated based on how much progress it would make and how it would address the identified issues related to fish and wildlife populations, habitats, land protection and conservation, education and visitor services, and refuge administration.

All of the management alternatives are designed for the area within the current approved acquisition boundary of 9,503 acres. The land protection alternatives are proposed independently of the management alternatives. Acquisition of a large area beyond the existing boundary would require a revision of the comprehensive conservation plan to develop programs that consider the larger area.

## DESCRIPTION OF ALTERNATIVES

The staff developed goals and three sets of objectives to achieve the refuge's purpose and the mission of the National Wildlife Refuge System. Objectives are desired conditions or outcomes that are grouped into sets and for this planning effort, consolidated into three alternatives. These alternatives, overall, represent a range of different management treatments or approaches for managing the refuge over a 15-year time frame. Alternative 1 is the status quo; alternative 2 provides for moderate program increases and a basic biology and public use program; alternative 3 provides for substantial program increases and survey and management of all wildlife groups and habitats. The three preliminary alternatives are summarized below and in Tables 25 through 29. The objectives and strategies that are different in Alternatives 2 and 3 than they are in Alternative 1 are underlined in the summaries below.

### *ALTERNATIVE 1 – NO ACTION*

This alternative represents the status quo, i.e., no change from current management of the refuge. Under this alternative, The Service would protect, maintain, restore, and enhance 8,219 acres of refuge lands for resident wildlife, waterfowl, migratory nongame birds, and threatened and endangered species. The staff would implement management programs with little baseline biological information. They would direct all refuge management actions towards achieving the refuge's primary purposes (preserving migratory habitat for waterfowl; providing production habitat for wood

ducks; and helping to meet the habitat conservation goals of the North American Waterfowl Management Plan), while contributing to other national, regional, and state goals to protect and restore neotropical breeding bird, wood duck, colonial nesting bird, and anadromous fish populations.

The Service will practice active habitat management through water management in managed wetlands (moist-soil units) and prescribed burning in marshes, mesic pine flatwoods forests, and coastal fringe evergreen forests. The staff would monitor wood duck boxes and band the requested number of wood ducks. The Service would cooperate with researchers from state and federal agencies, universities, and non-governmental organizations

The Service would maintain the current level of wildlife-dependent recreation activities (hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation opportunities). Administrative roads would be available as hiking trails to support wildlife-dependent recreation to the extent that these opportunities do not interfere substantially with or detract from the achievement of wildlife conservation. The staff would maintain one observation platform, three trails, and six interpretive kiosks. The refuge would continue quality-hunting programs for 450 annual users consistent with sound biological principles. The Service would permit fishing for 15,000 annual users in along the canals and managed wetlands. The staff would conduct three environmental education programs for 100 annual users only as requested, maintain interpretive materials and facilities for 5,000 annual users, and conduct outreach for an audience of 90,000. They would maintain wildlife observation facilities for 70,000 annual users and wildlife photography facilities for 700 annual users.

Under this alternative, the refuge would continue to seek acquisition of all willing-seller properties within the present acquisition boundary (Figure 5). The Service would make lands acquired as part of the refuge available for compatible public wildlife-dependent recreation and environmental education opportunities. Purchases from willing sellers would be the preferred option to expand conservation efforts in the acquisition area. Other important options include outreach and partnerships with adjacent landowners, hunt clubs, and the Natural Resources Conservation Service through conservation easements, cooperative agreements, and federal programs, such as the Wetlands Reserve Program. These land conservation options would promote the linkage of forest and brackish marsh tracts and contribute to overall natural resource conservation within the acquisition area.

The refuge would enforce regulations as violations occur. The staff would have the capacity to review eight special use permits per year, but would not monitor the effects of the activities allowed by the permits. They would control pest animals and plants as they find them. The Service would monitor water quality periodically as time permits.

The Service would maintain the refuge as funding allows. The staff would have eight members. The volunteer program would have an annual target of 1,000 hours, would be coordinated by a collateral duty staff member, and would maintain the existing intern program.

*ALTERNATIVE 2*

This alternative would implement a program to develop a Habitat Management Plan, manage fire-dependent communities and moist-soil units, inventory neotropical migratory songbirds and shorebirds, and increase the public use program to provide all six priority public uses (hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation). This alternative would also add the staff, equipment, and facilities to support the programs. Under this alternative, the Service would protect, maintain, restore, and enhance 8,219 acres of refuge lands for resident wildlife, waterfowl, migratory nongame birds, and threatened and endangered

species. The refuge staff would initiate limited wildlife and plant censuses and inventory activities to obtain the biological information needed to implement management programs on the refuge. They would direct all management actions towards achieving the refuge's primary purposes (preserving habitat for migratory waterfowl, providing production habitat for wood ducks; and helping to meet the habitat conservation goals of the North American Waterfowl Management Plan), while contributing to other national, regional, and state goals to protect and restore shorebird, neotropical breeding bird, wood duck, and anadromous fish populations.

The Service would develop a Habitat Management Plan and practice active habitat management through water management in managed wetlands (moist-soil units), and prescribed burning in marshes, mesic pine flatwoods forest, and coastal fringe evergreen forest. The refuge would also manage the canopy in the forests by thinning. The staff would monitor wood duck boxes and band the requested number of wood ducks. They would conduct six bi-weekly aerial and ground waterfowl surveys. The refuge would also perform abomasal parasite counts on deer to assess the condition of the population. It would document presence or absence surveys of all wildlife, and inventory land birds. The Service would cooperate with researchers from state and federal agencies, universities, and non-governmental organizations

The Service would increase opportunities for wildlife-dependent recreation activities (hunting, fishing, wildlife observation, and interpretation) and environmental education opportunities. The road to the office and the office area would be open every other weekend and Mackay Island Road would be open to the pump house from March 15 to October 15. The staff would maintain the existing wildlife observation platforms, six interpretive kiosks, and three trails. They would continue quality-hunting programs for 600 annual users consistent with sound biological principles. The Service would permit fishing for 20,000 annual users along the shorelines of the bays and sounds and banks of drainage ditches and impoundments. The staff would plan and conduct eight environmental education programs for 350 annual users on a request basis only, maintain interpretive materials and facilities for 10,000 annual users, and conduct outreach efforts for a target audience of 250,000. They would schedule twenty annual tours; develop additional printed interpretive material; and build and maintain an environmental education center, a second observation platform, two photo blinds, a second interpretive trail, and a seventh kiosk (Figure 7).

Under this alternative, the refuge would continue to seek acquisition of all willing-seller properties within the present acquisition boundary (Figure 5). The Service would make lands acquired as part of the refuge available for compatible public wildlife-dependent recreation and environmental education opportunities. Purchases from willing sellers would be the preferred option to expand conservation efforts in the acquisition area. Other important options include outreach and partnerships with adjacent landowners, hunt clubs, and the Natural Resources Conservation Service through conservation easements, cooperative agreements, and federal programs such as the Wetlands Reserve Program. These land conservation options would promote the linkage of forest and marsh tracts and contribute to overall natural resource conservation within the acquisition area.

The refuge would enforce regulations as violations occur, but would also increase outreach to make visitors aware of the regulations and the reasons for them. The staff would have the capacity to review twelve special use permits per year, would develop standard conditions for similar permits, and monitor the effects of the activities allowed by the permits. They would monitor pest animals and plants and control them in accordance with a pest control plan. The Service would monitor water quality in the impoundments and marsh quarterly.

The Service would maintain the refuge to assure the safety of the staff and visitors.

The refuge would construct and maintain a vehicle maintenance shop, fire cache, and heating and ventilation system for the existing shop. The staff would have fifteen members with the addition of a second assistant manager, a wildlife biologist, a fire management specialist, two biological technicians, an outdoor recreation planner, a clerk, and a maintenance worker. The volunteer program would have an annual target of 3,500 hours and would be coordinated by a designated staff member, and include an expanded intern program.

*ALTERNATIVE 3*

This alternative would develop and implement a program to manage and restore the refuge's forest and hydrology in support of migratory birds and other wildlife, and increase the public use program to provide all six priority public uses (hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation) with more emphasis on education, interpretation, and wildlife observation. This alternative would also add the staff, equipment, and facilities to support the programs. Under this alternative, the Service would protect, maintain, restore, and enhance 8,219 acres of refuge lands for resident wildlife, waterfowl, migratory nongame birds, and threatened and endangered species.

The refuge staff would initiate extensive wildlife and plant censuses and inventory activities to obtain the biological information needed to implement management programs on the refuge. This alternative would add non-breeding bird censuses, wood duck cavity and fisheries surveys, and reptile and amphibian studies. The refuge would direct all management actions towards achieving the refuge's primary purposes (preserving migratory habitat for waterfowl and shorebirds, migratory and breeding habitat for neotropical migratory songbirds; providing production habitat for wood ducks; and helping to meet the habitat conservation goals of the North American Waterfowl Management Plan), while contributing to other national, regional, and state goals to protect and restore shorebird, neotropical breeding bird, wood duck, and anadromous fish populations.

The Service would develop habitat management plans and practice active habitat management through water management in managed wetlands (moist-soil units), and prescribed burning in marshes, mesic pine flatwoods forest, and coastal fringe evergreen forest. The refuge would also manage the canopy in the forests by thinning. The staff would monitor wood duck boxes and band the requested number of wood ducks. They would conduct six bi-weekly aerial and ground waterfowl surveys. They would also perform abomasal parasite counts on deer to assess the condition of the population. They would document presence or absence surveys of all wildlife, and inventory land birds and mammals. The Service would cooperate with researchers from state and federal agencies, universities, and non-governmental organizations

The Service would increase opportunities for wildlife-dependent recreation activities (hunting, fishing, and wildlife observation, and interpretation) and environmental education opportunities. The office area and the road to the office would be open every weekend, and Mackay Island Road would be open to the pump house from March 15 until October 15. The refuge staff would maintain the existing wildlife observation platform, six interpretive kiosks, and three trails. They would continue quality-hunting programs for 800 annual users consistent with sound biological principles. The Service would permit fishing for 25,000 annual users along the shorelines of bays and sounds and banks of drainage ditches and impoundments. The staff would plan more environmental education programs for 500 annual users on a request basis only, maintain interpretive materials and facilities for 10,000 annual users, and conduct outreach efforts for a target audience of 500,000. They would schedule twenty annual tours; develop printed interpretive material; and build and maintain an environmental education center, a second observation platform, two photo blinds, a third interpretive trail, a canoe trail, and a seventh and eighth kiosks.

Under this alternative, the refuge would continue to seek acquisition of all willing-seller properties within the present acquisition boundary (Figure 5). Lands acquired as part of the refuge could be available for compatible public wildlife-dependent recreation and environmental education opportunities. The purchase of land from willing sellers would be the preferred option to expand conservation efforts in the acquisition area. Other important options include outreach and partnerships with adjacent landowners, hunt clubs, and the Natural Resources Conservation Service through conservation easements, cooperative agreements, and federal programs such as the Wetlands Reserve Program. These land conservation options would promote the linkage of forest and marsh tracts and contribute to overall natural resource conservation within the acquisition area.

The refuge would enforce regulations as violations occur, but would also increase outreach to make visitors aware of the regulations and the reasons for them. The staff would have the capacity to review twenty special use permits per year, would develop standard conditions for similar permits, and monitor the effects of the activities allowed by the permits. They monitor pest animals and plants and control them in accordance with a pest control plan. The Service would monitor water quality monthly.

The Service would maintain the refuge to assure the safety of the staff and visitors, efficiency to minimize repairs, and aesthetics of the buildings and grounds. The refuge would construct and maintain a vehicle maintenance shop, fire cache, and heating and ventilation system for the existing shop. The staff would have twenty members with the addition of a second assistant manager, a wildlife biologist, a fire management specialist, two biological technicians, a forestry technician, two outdoor recreation planners, and a second park ranger for law enforcement, two clerks, a maintenance worker, and a tractor operator. The volunteer program would have an annual target of 5,000 hours and would be coordinated by a designated staff member, and include an expanded intern program.

## FEATURES COMMON TO ALL ALTERNATIVES

### *LAND ACQUISITION*

The staff would give the acquisition of land adjacent to Service-owned lands within the refuge acquisition boundary the highest priority. All land acquisitions are subject to contaminant surveys.

Funding for land acquisition would come from the Land and Water Conservation Fund, Migratory Bird Conservation Fund or donations from conservation organizations. The Service could use conservation easements and leases sometimes to obtain minimum interests necessary to satisfy refuge objectives if the staff could adequately manage uses of the areas for the benefit of wildlife. The Service could negotiate management agreements with local, state, and federal agencies, and accept conservation easements. Public or private conservation organizations may own some tracts within the proposed refuge acquisition boundary. The Service would work with interested organizations to identify additional areas needing protection and provide technical assistance if needed. The acquisition of private lands is entirely contingent on the landowners and their willingness to participate.

### *REFUGE REVENUE SHARING*

Annual refuge revenue-sharing payments to Currituck County would continue at similar rates under each alternative. If the Service acquires lands and adds them to the refuge, the payments would increase accordingly.

**Figure 7. Proposed visitor facilities at the Mackay Island National Wildlife Refuge under Alternative 2.**

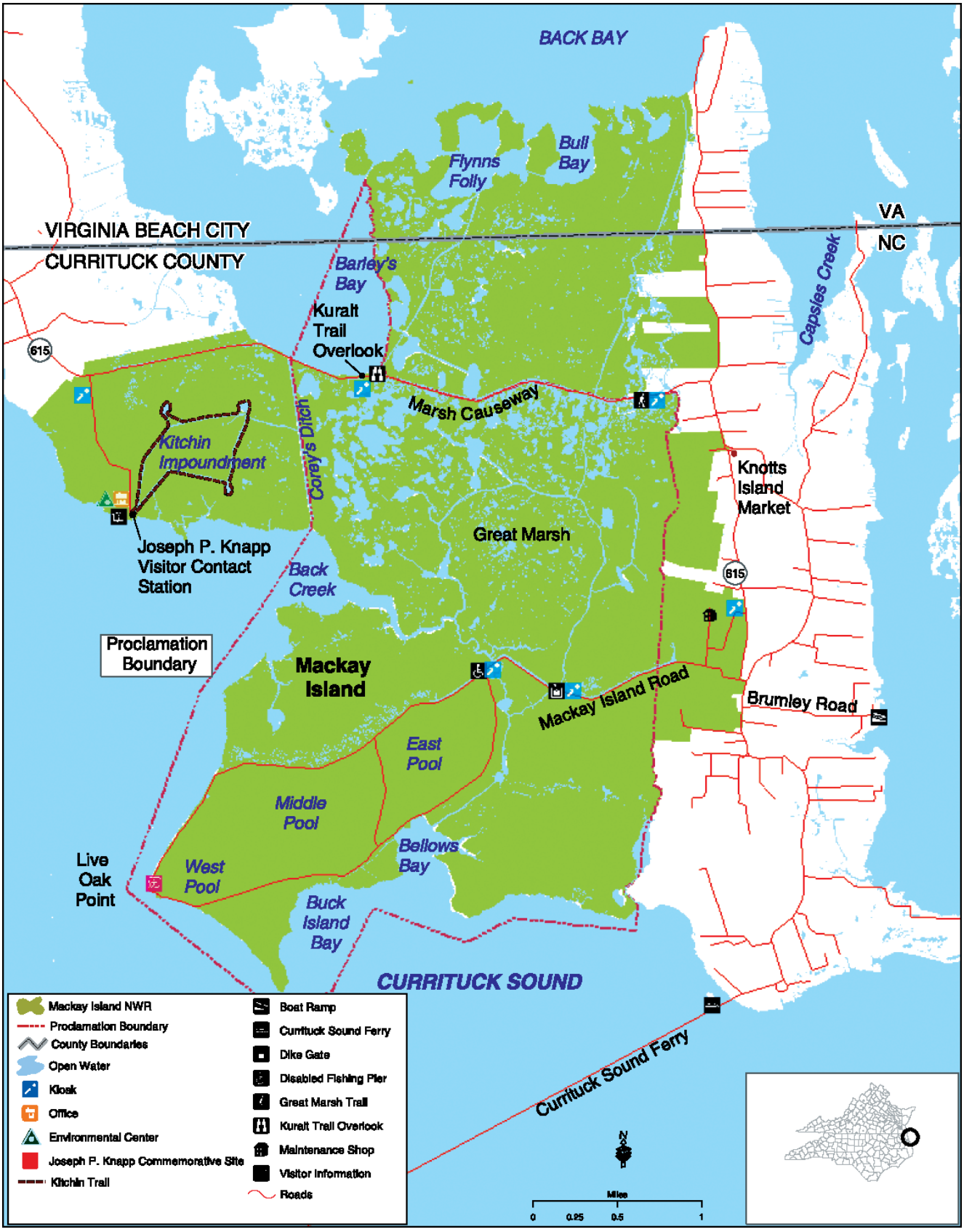


**Table 25. Summary of wildlife objectives and strategies.**

| Wildlife | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| **Fish** | Manage refuge for water quality | Yes | Yes | Yes |
| | Cooperative studies | Yes | Yes | Yes |
| | Perform baseline inventory | No | Yes | Yes |
| | Develop and implement management plan | No | Yes | Yes |
| **Invertebrates** | Cooperative studies | Yes | Yes | Yes |
| | Document presence or absence | No | Yes | Yes |
| | Document density in moist-soil units | No | No | Yes |
| | Analyze results of studies | No | No | Yes |
| **Land Birds** | Number of species | 115 | 115 | 115 |
| | Cooperative studies | Yes | Yes | Yes |
| | Assist with banding | Yes | Yes | Yes |
| | Monitor eagle nests | Yes | Yes | Yes |
| | Establish inventory protocol | No | Yes | Yes |
| | Develop and implement inventory plan | No | Yes | Yes |
| | Identify priority species | No | Yes | Yes |
| | Correlate birds to habitat | No | Yes | Yes |
| **Mammals** | Cooperative studies | Yes | Yes | Yes |
| | Conduct APC counts | No | Yes | Yes |
| | Monitor and manage deer population | No | Yes | Yes |
| | Document presence or absence | No | Yes | Yes |
| | Inventory mammal species | No | No | Yes |

**Table 25. Summary of wildlife objectives and strategies (continued)**

| Wildlife | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| **Reptiles and Amphibians** | Cooperative studies | Yes | Yes | Yes |
| | Document presence or absence | No | From Incidental Sightings | From Intensive Surveys |
| | Develop and implement inventory plan | No | No | Yes |
| | Analyze results of studies | No | No | Yes |
| **Shorebirds** | Cooperative studies | Yes | Yes | Yes |
| | Assist with banding, studies, investigations as requested | No | Yes | Yes |
| | Conduct surveys every 10 days | No | No | Yes |
| **Wading Birds and Marshbirds** | Assist with surveys as requested | Yes | Yes | Yes |
| | Cooperative studies | Yes | Yes | Yes |
| | Observe productivity of wading bird rookeries | No | No | Yes |
| **Waterfowl** | Cooperative studies | Yes | Yes | Yes |
| | Conduct 6 bi-weekly aerial surveys | No | Yes | Yes |
| | Conduct 6 bi-weekly ground surveys | No | Yes | Yes |
| | Conduct/assist with banding | No | Yes | Yes |
| | Monitor success of wood duck boxes | 120 | 120 | 120 |
| | Band summer wood ducks | 100 | 100 | 100 |
| | Assist with studies as requested | No | Yes | Yes |

**Table 26. Summary of habitat objectives and strategies.**

| Habitat | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| **All Habitats** | Implement Water Management Plan | Yes | Yes | Yes |
| | Implement Fire Management Plan | Yes | Yes | Yes |
| | Initiate development of Habitat Management Plan | No | Yes | Yes |
| | Implement Habitat Management Plan | No | Yes | Yes |
| **Brackish Marsh/Wet Meadow** | Acreage | 4,251 | 4,251 | 4,251 |
| | Wildfire management | Yes | Yes | Yes |
| | Prescribed burning | Yes | Yes | Yes |
| | Monitor vegetation for fire effects | No | Yes | Yes |
| | Monitor vegetation for effects of geese and nutria | No | Yes | Yes |
| | Adapt Habitat Management Plan to the results of monitoring | No | Yes | Yes |
| **Coastal Fringe Evergreen Forest** | Acreage | 1,515 | 1,515 | 1,515 |
| | Manage wildfire | Yes | Yes | Yes |
| | Monitor southern pine beetle | Yes | Yes | Yes |
| | Monitor gypsy moth | Yes | Yes | Yes |
| | Inventory vegetation | No | No | Yes |
| | Implement Habitat Management Plan | No | Yes | Yes |
| **Mesic Pine Flatwood Forest** | Acreage | 131 | 131 | 131 |
| | Manage wildfire | Yes | Yes | Yes |
| | Monitor gypsy moth | Yes | Yes | Yes |
| | Inventory vegetation | No | Yes | Yes |
| | Implement Habitat Management Plan | No | Yes | Yes |
| **Open Water** | Manage land to protect | Yes | Yes | Yes |
| | Monitor submerged aquatic vegetation | No | No | Yes |
| **Cropland** | Acreage | 280 | 280 | 280 |
| | Winter browse acreage | 80 | 80 | 80 |
| | Provide grain through sanctuary program | No | Yes | Yes |
| **Firebreaks** | Acreage (miles) | 8 (2) | 8 (2) | 8 (2) |

**Table 26. Summary of habitat objectives and strategies (continued).**

| Habitat | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| **Moist-Soil Units** | Acreage | 955 | 955 | 955 |
| | Evaluate vegetation | Annually | Annually | Annually |
| | Good vegetation goal | 50% | 50% | 50% |
| | Spring mudflat goal | 20% | 20% | 20% |
| | Fall mudflat goal | None | 10% | 10% |
| | Evaluate invertebrates | No | No | Yes |
| **Roads** | Acreage (miles) maintained | 220 (9.2) | 220 (9.2) | 220 (9.2) |
| **Wood Duck Boxes** | Number of boxes maintained | 120 | 120 | 120 |
| | New boxes erected | No | As Use Reaches 60% | As Use Reaches 60% |

**Table 27. Summary of public use objectives and strategies.**

| Topic | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| **Visitor Use Measurement** | Survey methodology | Staff Observation | Automated Counters | Surveys and Automated Counters |
| **Hunting** | Annual deer hunter use days | 450 | 600 | 800 |
| | Disabled hunting Area | Yes | Yes | Yes |
| | Hunting brochure revision | Yes | Yes | Yes |
| | Annual Hunter Safety Course | Yes | Yes | Yes |
| | Maintain information exhibit and signs | Yes | Yes | Yes |

**Table 27. Summary of public use objectives and strategies (Continued).**

| Topic | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| **Fishing** | Annual use days | 15,000 | 20,000 | 25,000 |
| | Disabled fishing area | Yes | Yes | Yes |
| | Maintain boat ramp | 1 | 1 | 1 |
| | Maintain information exhibit and signs | Yes | Yes | Yes |
| | Host National Fishing Week event | No | Yes | Yes |
| **Environmental Education** | Annual visitors | 100 | 350 | 500 |
| | Annual programs | 3 on Request | 8 on Request | 8 on Request |
| | Update visitor contact station exhibits | No | Yes | Yes |
| | Develop Environmental Education Plan | No | Yes | Yes |
| | Develop education center exhibits | No | Yes | Yes |
| **Interpretation** | Annual visitors | 5,000 | 10,000 | 10,000 |
| | Revise refuge brochure | Yes | Yes | Yes |
| | Revise bird list | Yes | Yes | Yes |
| | Maintain web site | Yes | Yes | Yes |
| | Kiosk maintenance | 6 | 7 | 8 |
| | New kiosk development | 0 | 1 | 2 |
| | Annual tours | 4 | 20 | 20 |
| | Develop kiosk interpretive panels | Yes | Yes | Yes |
| | Utilize education center for interpretation | No | Yes | Yes |

**Table 27. Summary of public use objectives and strategies (continued)**

| Topic | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| **Interpretation** | Develop Joseph P. Knapp residence site exhibits, brochure, and trail | No | Yes | Yes |
| | Develop signage for Great Marsh Trail | No | Yes | Yes |
| | Develop Kitchin Interpretative Trail | No | Yes | Yes |
| | Develop youth wildlife checklist | No | Yes | Yes |
| | Develop third interpretative trail | No | No | Yes |
| | Develop and maintain canoe trail | No | No | Yes |
| | Install remote camera | No | No | Yes |
| | Develop refuge video | No | No | Yes |
| **Wildlife Observation** | Annual visitors | 70,000 | 90,000 | 100,000 |
| | Revise bird list | Yes | Yes | Yes |
| | Maintain Kuralt Trail Overlook and Three Trails | Yes | Yes | Yes |
| | Develop and maintain new observation platform at Kitchin Impoundment | No | Yes | Yes |
| | Develop and maintain canoe trail | No | No | Yes |
| **Wildlife Photography** | Annual visitors | 700 | 900 | 1,00 |
| | Revise bird list | Yes | Yes | Yes |
| | Maintain Kuralt Trail Overlook and Three Trails | Yes | Yes | Yes |
| | Develop and maintain observation platform | No | Yes | Yes |
| | Develop and maintain canoe trail | No | No | Yes |
| | Develop and maintain photo blinds | None | One | Two |

**Table 27. Summary of public use objectives and strategies (continued).**

| Topic | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| **Access** | Regular pedestrian access | Daylight Hours March 15 – October 15 | Daylight Hours March 15 – October 15 | Daylight Hours March 15 – October 15 |
| | Office | Monday-Friday 7:30AM – 4:00PM | Monday-Friday 7:30AM – 4:00PM Every Saturday | Monday-Friday 7:30AM – 4:00PM Every Weekend |
| | Mackay Island Road | To the Dike Gate Year-round | To the Dike Gate Year-round, To the Disabled Fishing Pier March 15 – October 15 | To the Dike Gate Year-round, To the Disabled Fishing Pier March 15 – October 15 |
| | Marshes and impoundments | March 15 - October 15 | March 15 - October 15 | March 15 - October 15 |
| **Outreach** | Target audience | 90,000 | 250,000 | 500,000 |
| | Annual local events | 6 | 7 | 8 |
| | Annual presentations to local organizations | 3 | 4 | 5 |
| | Annual news releases | 10 | 12 | 12 |
| | Publish newsletter | Annually | Quarterly | Quarterly |
| | Publicize on local access cable | No | Yes | Yes |
| | Participate in state fair | No | Yes | Yes |
| **Refuge Support** | Work with established groups | Yes | Yes | Yes |
| | Develop Mackay Chapter of CWRS | No | Yes | Yes |
| | Maintain retail outlet | Yes | Yes | Yes |
| | Establish gift shop in education center | No | No | Yes |
| **Special Events** | Number | 4 | 6 | 6 |

**Table 28. Summary of resource protection objectives and strategies.**

| Topic | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| **Cultural Resources** | Protect identified sites | Yes | Yes | Yes |
| | Evaluate proposed projects | Yes | Yes | Yes |
| | Conduct comprehensive inventory | No | No | Yes |
| **Interagency Coordination** | Annual formal and informal coordination meetings | 50 | 70 | 90 |
| | Review and revise agreements | Yes | Yes | Yes |
| | Coordinate with NC Forest Service | Yes | Yes | Yes |
| | Pursue agreement on navigable waters | Yes | Yes | Yes |
| | Develop agreement on waterfowl rest areas | No | Yes | Yes |
| **Land Protection** | Acreage | 180 | 180 | 180 |
| | Post boundary | Yes | Yes | Yes |
| | Inventory habitat | No | Yes | Yes |
| | Manage area | No | No | Yes |
| **Law Enforcement** | Ensure health and safety by: | Enforce regulations | Enforce regulations and outreach | Enforce regulations and outreach |
| | Coordinate with others | Yes | Yes | Yes |
| | Develop relationships | No | Yes | Yes |
| | Develop written agreements | No | Yes | Yes |

**Table 28. Summary of resource protection objectives and strategies (continued).**

| Topic | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| Permits | Evaluation capacity | 8 | 12 | 20 |
| | Develop special use conditions | Yes | Yes | Yes |
| | Develop standardized conditions | No | Yes | Yes |
| | Monitor permitted activities | No | Yes | Yes |
| Topic | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
| Pest Animals | Control pests | Yes | Yes | Yes |
| | Develop Nuisance Animal Control Plan | No | Yes | Yes |
| Pest Plants | Monitor, control, eradicate | Yes | Yes | Yes |
| | Develop Pest Plant Control Plan | No | Yes | Yes |
| State Natural Heritage Areas | Limit impacts to retain character | Yes | Yes | Yes |
| | Prescribed fire | Yes | Yes | Yes |
| Water Quality | Duration of monitoring in Kitchin Impoundment | Until 2008 | Until 2008 | Until 2008 |
| | Frequency of monitoring in impoundments, canals, pump stations | Periodic | Quarterly | Monthly |
| | Cooperate with other agencies | Yes | Yes | Yes |
| Wilderness Areas | Acres nominated | 0 | 0 | 0 |
| Wildlife Disease | Monitor and control | Yes | Yes | Yes |
| | Coordinate with others | Yes | Yes | Yes |

**Table 29. Summary of administration objectives and strategies.**

| Topic | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| **Capital Property** | Annual inventories | 1 | 1 | 1 |
| | Maintain records | As time allows | Adequately | Adequately |
| | Evaluate condition | No | Yes | Yes |
| | Maintenance/ replacement goal | As breaks down | Ensure safety | Ensure safety and maximize efficiency |
| **Office/Visitor Contact Station/Environmental Education Center** | Operation and maintenance goal | Efficiency, safety, aesthetics | Efficiency, safety, aesthetics | Efficiency, safety, aesthetics |
| | New office construction/ environmental education center renovation | No | Yes | Yes |
| **Shop Facilities** | Operation and maintenance goal | Efficiency and safety | Efficiency and safety | Efficiency and safety |
| | Construct and maintain vehicle maintenance shop | No | Yes | Yes |
| | Construct and maintain fire cache | No | Yes | Yes |
| | Construct and maintain heating and ventilation system for existing shop | No | Yes | Yes |
| **Personnel** | FTE levels | 7 | 15 | 20 |
| | Training | As funding allows | Per Service policy | Per Service policy |
| | Performance evaluation | Yes | Yes | Yes |
| | Encourage details for training | Yes | Yes | Yes |

**Table 29. Summary of administration objectives and strategies (continued).**

| Topic | Activity | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| **Real Property** | Maintenance goals | As funding allows | Cleanliness and safety | Cleanliness and safety |
| | Building construction | None | To adequate levels | To meet all needs |
| | Annual real property inventory | 1 | 1 | 1 |
| | Real property management | Per Manual | Per Manual | Per Manual |
| | Pursue resolution of boundary disputes | Yes | Yes | Yes |
| **Volunteer Coordination** | Annual target hours | 1,000 | 1,000 | 5,000 |
| | Coordination | Collateral duty | Designated staff member | Designated staff member |
| | Intern program | Maintain | Expand | Expand |

**Table 30. Summary of projects proposed in each alternative.**

| Project Description | Alternatives | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| **Staff Projects** | | | |
| Utilize existing GS-13 manager (55% Mackay Island). | X | X | X |
| Utilize existing GS-9 assistant manager (65% Mackay Island). | X | X | X |
| Utilize existing GS-9 park ranger (law enforcement) (25% Mackay Island). | X | X | X |
| Utilize existing GS-5 office assistant (85% Mackay Island). | X | X | X |
| Utilize existing WG-10 maintenance mechanic (85% Mackay Island). | X | X | X |
| Utilize existing WG-8 engineering equipment operator (60% Mackay Island). | X | X | X |
| Utilize existing GS-5 forestry technician (60% Mackay Island). | X | X | X |
| Recruit, hire train a new GS-9 biologist (RONS 97006) (65% Mackay Island). | | X | X |
| Recruit, hire, train a new GS-4 clerk (RONS 99004) (55% Mackay Island). | | X | X |
| Recruit, hire, train a new WG-8 maintenance worker (RONS 00019)(55% Mackay Island). | | X | X |
| Recruit, hire, train a second new GS-7 biological technician (RONS 00013)(55% Mackay Island). | | X | X |
| Recruit, hire, train a new GS-9 fire management specialist (RONS 00009)(60% Mackay Island). | | X | X |
| Recruit, hire, train a new GS-9 outdoor recreation planner (Currituck)(RONS 97013)(40% Mackay Island). | | X | X |
| Recruit, hire, train a new GS-7 biological technician (Currituck)(RONS 00001)(10% Mackay Island). | | X | X |
| Recruit, hire, train a new GS-9 assistant manager (Currituck) (RONS 00011)(5% Mackay Island). | | X | X |
| Recruit, hire, train a new GS-7 park ranger (law enforcement) (Currituck)(RONS 03000)(5% Mackay Island). | | | X |
| Recruit, hire, train a new WG-7 tractor operator (RONS 97004) (65% Mackay Island). | | | X |
| Recruit, hire, train a new GS-7 outdoor recreation planner (Mackay Island) (RONS 00018)(40% Mackay Island). | | | X |
| Recruit, hire, train a new GS-5 forestry technician (temporary) (65% Mackay Island) | | | X |
| Recruit, hire, train a new GS-4 clerk (half time) (55% Mackay Island) | | | X |

**Table 30. Summary of projects proposed in each alternative (continued)**

| Project Description | Alternatives | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| **Budget Projects** | | | |
| Process payroll, travel, purchasing, and contract documents. | X | X | X |
| Prepare annual budget, revise RONS and MMS. | X | X | X |
| Apply for grants. | X | X | X |
| Budget Projects (Mackay Island NWR) | | | |
| Perform Federal Highway Administration Public Use Road Survey (MMS 02013) | X | X | X |
| Control exotic Phragmites stands (RONS 99001) | X | X | X |
| Develop outreach tools (RONS 00002) | X | X | X |
| Monitor water quality parameters (RONS 00005) | X | X | X |
| Complete cultural resource survey (RONS 97009). | | X | X |
| Improve fire management program (RONS 97011) | | X | X |
| Complete forest management plans (RONS 99003) | | X | X |
| Enhance migratory bird management (RONS 00006) | | X | X |
| Conduct fisheries survey (RONS 00010) | | X | X |
| Research and restore areas impacted by goose grazing (RONS 00003) | | | X |
| **Equipment Projects** | | | |
| Maintain vehicles and boats. | X | X | X |
| Maintain heavy equipment and hand tools. | X | X | X |
| Maintain computers and software. | X | X | X |
| Replace Chevy Astro van (MMS 97033) | X | X | X |
| Replace 1989 Blue Dodge pickup truck (MMS 00003) | X | X | X |
| Replace 1998 airboat (MMS 01002) | X | X | X |
| Replace D-4 dozer (MMS 01003) | X | X | X |
| Replace heavy duty disc (MMS 01004) | X | X | X |
| Replace backhoe (MMS 01005) | X | X | X |
| Replace tracked marsh vehicle (MMS 01006) | X | X | X |
| Replace 14-foot rotary mower (MMS 01007) | X | X | X |
| Replace 16-inch high volume lift pump (MMS 01008) | X | X | X |
| Replace 1996 4x4 Ford tractor (MMS 01010) | X | X | X |
| Replace 1988 Case 585 tractor (MMS 01011) | X | X | X |
| Replace 1991 15-ton tilt bed tractor (MMS 01012) | X | X | X |
| Replace 1998 tilt-bed trailer (MMS 01013) | X | X | X |
| Replace 1996 4X4 Dodge Dakota (MMS 01014) | X | X | X |
| Replace 2001 Chevrolet Tahoe (MMS 01016) | X | X | X |
| Replace 1999 Ford F-250 4X4 truck (MMS 01017) | X | X | X |
| Replace 1998 Ford F-250 4X4 truck (MMS 01018) | X | X | X |

**Table 30. Summary of projects proposed in each alternative (continued)**

| Project Description | Alternatives | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| **Equipment Projects (continued)** | | | |
| Replace 1995 Ford F-250 4X4 truck (MMS 01019) | X | X | X |
| Replace 1995 Ford F-150 4X4 extended cab truck (MMS 01020) | X | X | X |
| Replace 18-foot, boat, 60-horsepower outboard motor, and trailer (MMS 02004) | X | X | X |
| Replace 2001 John Deere 670CH Motor Grader (MMS 02005) | X | X | X |
| Replace 2001 Kubota M8200 tractor (MMS 02006) | X | X | X |
| Replace 2001 Alamo side mower (MMS 02007) | X | X | X |
| Replace 2001 Ingersoll-Rand RT706H forklift (MMS 02008) | X | X | X |
| Replace 1991 Chevrolet fire engine (MMS 02009) | X | X | X |
| Replace 20-foot, boat, 70-horsepower outboard motor, and trailer (MMS 02011) | X | X | X |
| Replace 2003 Ford F250 extended cab truck (MMS 04001). | X | X | X |
| Replace 2003 Freightliner 6X4 stake bed dump truck (MMS 04002). | X | X | X |
| **Facility Projects** | | | |
| Maintain roads. | X | X | X |
| Maintain parking lots and trails. | X | X | X |
| Maintain buildings. | X | X | X |
| Maintain public use facilities. | X | X | X |
| Resurface Mackay Island Road (MMS 94001) | X | X | X |
| Replace deteriorated bulkhead at Bulls Bay (MMS 95004) | X | X | X |
| Replace deteriorated bulkhead at Bellows Bay (MMS 95005) | X | X | X |
| Resurface Long Dike (MMS 96003) | X | X | X |
| Rehabilitate fire cache (MMS 96005) | X | X | X |
| Rehabilitate Refuge roads (MMS 96006) | X | X | X |
| Regravel Mackay Island Road (MMS 96008) | X | X | X |
| Construct observation platform and fishing pier (MMS 97003 – Old RONS) | X | X | X |
| Replace office bulkhead (MMS 97006) | X | X | X |
| Repair parallel dike at East Pool (MMS 97007) | X | X | X |
| Construct a wildlife observation and photography blind at the East Pool (MMS 97007 – Old RONS)) | X | X | X |

**Table 30. Summary of projects proposed in each alternative (continued)**

| Project Description | Alternatives | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| **Facility Projects (continued)** | | | |
| Repair Lower Kitchin impoundment dikes/water control structures (MMS 97008) | X | X | X |
| Rehabilitate Long Dike and East Pool Dike (MMS 99002) | X | X | X |
| Replace bulkhead and boat ramp at Live Oak Point (MMS 00008) | X | X | X |
| Rehabilitate office entrance road (MMS 00011) | X | X | X |
| Repair water control structures (MMS 00014) | X | X | X |
| Rehabilitate office parking lot (MMS 00016) | X | X | X |
| **Facility Projects** | | | |
| Rehabilitate office entrance road (MMS 00017) | X | X | X |
| Expand Refuge headquarters (MMS 00018) | X | X | X |
| Replace bulkhead surrounding Mackay Island (MMS 01001) | X | X | X |
| Replace East Pool pump (MMS 01022) | X | X | X |
| Resurface Refuge parking lot (MMS 02010) | X | X | X |
| Re-survey and post proclamation boundary (MMS 02012) | X | X | X |
| Rehabilitate shop entrance road (MMS 03001) | X | X | X |
| Rehabilitate Live Oak Point Road (MMS 03002) | X | X | X |
| Rehabilitate Hog Pen Point Road (MMS 03003) | X | X | X |
| Rehabilitate Cross Dike (MMS 03004) | X | X | X |
| Rehabilitate office entrance road (MMS 03005) | X | X | X |
| Rehabilitate five Refuge parking lots (MMS 03006) | X | X | X |
| Expand fire management facility (MMS 00008 – Old RONS)) | X | X | X |
| Build a shop addition with a vehicle lift (MMS 00015 – Old RONS) | X | X | X |
| Construct new office building (MMS 02001) | X | X | X |
| Restore hydrology by installing box culverts along NC Highway 615 (MMS 02002) | X | X | X |
| Build an equipment storage building and garage at the office (MMS 03007) | X | X | X |
| Replace 30-inch pump and bulkhead (MMS 04003). | X | X | X |
| Replace bunkhouse (MMS 04004). | X | X | X |
| Replace fire cache/quarters (MMS 04005). | X | X | X |
| Replace residence entrance road (MMS 04005). | X | X | X |
| Build an equipment storage building and garage at the office (MMS 03007) | X | X | X |
| Build a vehicle and equipment wash rack (RONS 00014) | | X | X |

**Table 31. Summary of costs of projects proposed in all alternatives.**

| Project Description | Costs | | |
|---|---|---|---|
| **Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| **Alternative 1** | | | |
| **Staff Projects** | $0 | $219,000 | $219,000 |
| **Budget Projects** | $128,500 | $25,500 | $154,000 |
| **Equipment Projects** | $1,262,000 | $0 | $1,262,000 |
| **Facility Projects** | $7,571,000 | $0 | $7,571,000 |
| **Total for Alternative 1 Projects** | $8,961,500 | $244,500 | $9,206,000 |
| **Alternative 2** | | | |
| **Staff Projects** | $247,250 | $428,100 | $675,350 |
| **Budget Projects** | $418,500 | $61,500 | $480,000 |
| **Equipment Projects** | $1,262,000 | $0 | $1,262,000 |
| **Facility Projects** | $7,589,000 | $4,000 | $7,593,000 |
| **Total for Alternative 2 Projects** | $9,517,500 | $493,600 | $10,011,100 |
| **Alternative 3** | | | |
| **Staff Projects** | $412,875 | $533,250 | $946,125 |
| **Budget Projects** | $477,500 | $62,500 | $540,000 |
| **Equipment Projects** | $1,262,000 | $0 | $1,262,000 |
| **Facility Projects** | $7,589,000 | $4,000 | $7,593,000 |
| **Total for Alternative 3 Projects** | **$9,741,375** | **$599,750** | **$10,341,125** |

**Table 32. Cost of projects proposed in Alternative 1.**

| Project Description | Costs | | |
|---|---|---|---|
| **Staff Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Existing GS-13 manager (55% Mackay Island). | $0 | $219,000 | $219,000 |
| Existing GS-9 assistant manager (65% Mackay Island). | | | |
| Existing GS-9 park ranger (25% Mackay Island). | | | |
| Existing GS-5 office assistant (85% Mackay Island). | | | |
| ExistingWG-10maintenance mechanic (85% Mackay Island). | | | |
| Existing WG-8 equipment operator (60% Mackay Island). | | | |
| Existing GS-5 forestry technician (60% Mackay Island). | | | |
| **Total for Staff Projects** | **$0** | **$219,000** | **$219,000** |
| | | | |
| **Budget Projects(Mackay Island NWR) (Contracts, Research)** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Control exotic Phragmites stands (RONS 99001). | $43,000 | $3,000 | $46,000 |
| Develop outreach tools (RONS 00002). | $70,000 | $16,000 | $86,000 |
| Monitor water quality parameters (RONS 00005). | $15,500 | $6,500 | $22,000 |
| Total for Budget Projects | $128,500 | $25,500 | $154,000 |
| **Equipment Projects** | | | |
| Replace Chevy Astro van (MMS 97033). | $31,000 | $0 | $31,000 |
| Replace 1989 Blue Dodge pickup truck (MMS 00003). | $28,000 | $0 | $28,000 |
| Replace 1998 airboat (MMS 01002). | $27,000 | $0 | $27,000 |
| Replace D-4 dozer (MMS 01003). | $159,000 | $0 | $159,000 |
| Replace heavy duty disc (MMS 01004). | $10,000 | $0 | $10,000 |
| Replace backhoe (MMS 01005). | $90,000 | $0 | $90,000 |
| Replace tracked marsh vehicle (MMS 01006). | $94,000 | $0 | $94,000 |

**Table 32. Cost of projects proposed in Alternative 1 (continued)**

| Project Description | Costs | | |
|---|---|---|---|
| **Equipment Projects** | **First Year or One Time Costs** | **Recurring Costs** | **First Year or One Time Costs** |
| Replace 14-foot rotary mower (MMS 01007). | $14,000 | $0 | $14,000 |
| Replace 16-inch high volume lift pump (MMS 01008). | $8,000 | $0 | $8,000 |
| Replace 1996 4X4 Ford tractor (MMS 01010). | $87,000 | $0 | $87,000 |
| Replace 1988 Case 585 tractor (MMS 01011). | $47,000 | $0 | $47,000 |
| Replace 1991 15-ton tilt-bed trailer (MMS 01012). | $16,000 | $0 | $16,000 |
| Replace 1998 tilt-bed trailer (MMS 01013). | $9,000 | $0 | $9,000 |
| Replace 1996 4X4 Dodge Dakota (MMS 01014). | $33,000 | $0 | $33,000 |
| Replace 2001 Chevrolet Tahoe (MMS 01016). | $37,000 | $0 | $37,000 |
| Replace 1999 Ford F-250 4X4 truck (MMS 01017). | $26,000 | $0 | $26,000 |
| Replace 1998 Ford F-250 4X4 truck (MMS 01018). | $26,000 | $0 | $26,000 |
| Replace 1995 Ford F-250 4X4 truck (MMS 01019). | $26,000 | $0 | $26,000 |
| Replace 1995 Ford F-150 4X4 extended cab truck (MMS 01020). | $29,000 | $0 | $29,000 |
| Replace 18-foot boat, 60-horsepower outboard motor, and trailer (MMS 02004). | $13,000 | $0 | $13,000 |
| Replace 2001 John Deere 670CH Motor Grader (MMS 02005). | $157,000 | $0 | $157,000 |
| Replace 2001 Kubota M8200 tractor (MMS 02006). | $47,000 | $0 | $47,000 |
| Replace 2001 Alamo side mower (MMS 02007). | $8,000 | $0 | $8,000 |
| Replace 2001 Ingersoll-Rand RT 706H forklift (MMS 02008). | $42,000 | $0 | $42,000 |
| Replace 1991 Chevrolet fire engine (MMS 02009). | $84,000 | $0 | $84,000 |
| Replace 20-foot boat, 70-horsepower outboard motor, and trailer (MMS 02011). | $16,000 | $0 | $16,000 |

**Table 32. Cost of projects proposed in Alternative 1 (continued)**

| Project Description | Costs | | |
|---|---|---|---|
| **Equipment Projects** | **First Year or One Time Costs** | **Recurring Costs** | **First Year or One Time Costs** |
| Replace 2003 Ford F250 extended cab truck (MMS 04001). | $28,000 | $0 | $28,000 |
| Replace 2003 Freightliner 6X4 stake bed dump truck (MMS 04002). | $70,000 | $0 | $70,000 |
| **Total for Equipment Projects** | **$1,262,000** | **$0** | **$1,262,000** |
| | | | |
| **Facility Projects (Mackay Island NWR)** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Resurface Mackay Island Road (MMS 94001). | $342,000 | $0 | $342,000 |
| Replace bulkhead at Bulls Bay with pilings and signs (MMS 95004). | $129,000 | $0 | $129,000 |
| Replace bulkhead at Bellows Bay with pilings and signs (MMS 95005). | $169,000 | $0 | $169,000 |
| Resurface Long Dike (MMS 96003). | $1,082,000 | $0 | $1,082,000 |
| Rehabilitate fire cache (MMS 96005). | $51,000 | $0 | $51,000 |
| Resurface Mackay Island Road (MMS 96008). | $514,000 | $0 | $514,000 |
| Construct observation platform and fishing pier (MMS 97003 – Old RONS)). | $31,000 | $0 | $31,000 |
| Replace office bulkhead (MMS97006). | $37,000 | $0 | $37,000 |
| Repair parallel dike at East Pool (MMS 97007). | $32,000 | $0 | $32,000 |
| Construct observation/photography blind. (MMS 97007 – Old RONS). | $31,000 | $0 | $31,000 |
| Repair Long Dike (MMS 99002). | $135,000 | $0 | $135,000 |
| Construct addition to fire management facilities (MMS 00008). | $80,000 | $0 | $80,000 |
| Rehabilitate office entrance road (MMS 00011). | $131,000 | $0 | $131,000 |
| Construct an additional bay to shop facilities (MMS 00015). | $78,000 | $0 | $78,000 |
| Rehabilitate office parking lot (MMS 00016). | $62,000 | $0 | $62,000 |
| Rehabilitate office entrance road (MMS 00017). | $274,000 | $0 | $274,000 |
| Expand Refuge headquarters (MMS 00018). | $334,000 | $0 | $334,000 |

**Table 32. Cost of projects proposed in Alternative 1 (continued)**

| Project Description | Costs | | |
|---|---|---|---|
| **Facility Projects (Mackay Island NWR)** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Replace bulkhead surrounding Mackay Island (MMS 01001). | $814,000 | $0 | $814,000 |
| Replace East Pool pump (MMS 01022). | $40,000 | $0 | $40,000 |
| Resurface Refuge parking lot (MMS 02010). | $42,000 | $0 | $42,000 |
| Re-survey and post proclamation boundary (MMS 02012). | $26,000 | $0 | $26,000 |
| Rehabilitate shop entrance road (MMS 03001). | $95,000 | $0 | $95,000 |
| Rehabilitate Live Oak Point Road (MMS 03002). | $435,000 | $0 | $435,000 |
| Rehabilitate Hog Pen Point Road (MMS 03003). | $568,000 | $0 | $568,000 |
| Rehabilitate Cross Dike Road (MMS 03004). | $317,000 | $0 | $317,000 |
| Rehabilitate office entrance road (MMS 03005). | $430,000 | $0 | $430,000 |
| Rehabilitate five Refuge parking lots (MMS 03006). | $57,000 | $0 | $57,000 |
| Construct storage building and garage (MMS 03007). | $77,000 | $0 | $77,000 |
| Replace 30-inch pump and bulkhead (MMS 04003). | $60,000 | $0 | $60,000 |
| Replace bunkhouse (MMS 04004). | $38,000 | $0 | $38,000 |
| Replace fire cache/quarters (MMS 04005). | $400,000 | $0 | $400,000 |
| Replace residence entrance road (MMS 04005). | $60,000 | $0 | $60,000 |
| Replace shop building (MMS 04006). | $600,000 | $0 | $600,000 |
| **Total for Facility Projects** | **$7,571,000** | **$0** | **$7,571,000** |
| **Grand Total** | **$9,206,000** | **$244,500** | **$9,206,000** |

**Table 33. Cost of projects proposed in Alternative 2.**

| Project Description | Costs | | |
|---|---|---|---|
| **Staff Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total Costs** |
| Existing GS-13 manager (55% Mackay Island). | | $219,000 | $219,000 |
| Existing GS-9 assistant manager (65% Mackay Island). | | | |
| Existing GS-9 park ranger (25% Mackay Island). | | | |
| Existing GS-5 office assistant (85% Mackay Island). | | | |
| ExistingWG-10maintenance mechanic (85% Mackay Island). | | | |
| Existing WG-8 equipment operator (60% Mackay Island). | | | |
| Existing GS-5 forestry technician (60% Mackay Island). | | | |
| New GS-9 biologist (RONS 97006) (65% Mackay Island). | $42,250 | $40,950 | $83,200 |
| New GS-9 outdoor recreation planner (RONS 97013)(40% Mackay Island). | $26,000 | $21,200 | $47,200 |
| New GS-7 biological technician (RONS 00013)(55% Mackay Island). | $41,250 | $40,700 | $81,950 |
| New GS-4 clerk (RONS 99004) (55% Mackay Island). | $41,250 | $27,500 | $68,750 |
| New WG-8 maintenance worker (RONS 00019)(55% Mackay Island). | $35,750 | $28,600 | $64,350 |
| New GS-9 fire management specialist (RONS 00009)(60% Mackay Island). | $51,000 | $41,400 | $92,400 |
| New GS-9 assistant manager (Currituck) (RONS 00011) (5% Mackay Island). | $3,250 | $3,450 | $6,700 |
| New GS-7 biological technician (Currituck) (RONS 00001) (10% Mackay Island). | $6,500 | $5,300 | $11,800 |
| **Total for Staff Projects** | **$247,250** | **$428,100** | **$675,350** |

**Table 33. Cost of projects proposed in Alternative 2 (continued).**

| Project Description | Costs | | |
|---|---|---|---|
| **Budget Projects (Contracts, Research)** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Complete cultural resource surveys (RONS 97009). | $80,000 | $0 | $80,000 |
| Improve fire management program (RONS 97011). | $81,000 | $2,000 | $83,000 |
| Control exotic Phragmites stands (RONS 99001). | $43,000 | $3,000 | $46,000 |
| Develop forest management plans (RONS 99003). | $67,000 | $0 | $67,000 |
| Develop outreach tools (RONS 00002). | $70,000 | $16,000 | $86,000 |
| Monitor water quality parameters (RONS 00005). | $16,500 | $5,500 | $22,000 |
| Enhance migratory bird management (RONS 00006). | $41,000 | $35,000 | $76,000 |
| Conduct fisheries survey (RONS 000010). | $20,000 | $0 | $20,000 |
| **Total for Budget Projects** | **$418,500** | **$61,500** | **$480,000** |
| **Equipment Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Replace Chevy Astro van (MMS 97033). | $31,000 | $0 | $31,000 |
| Replace 1989 Blue Dodge pickup truck (MMS 00003). | $28,000 | $0 | $28,000 |
| Replace 1998 airboat (MMS 01002). | $27,000 | $0 | $27,000 |
| Replace D-4 dozer (MMS 01003). | $159,000 | $0 | $159,000 |
| Replace heavy duty disc (MMS 01004). | $10,000 | $0 | $10,000 |
| Replace backhoe (MMS 01005). | $90,000 | $0 | $90,000 |
| Replace tracked marsh vehicle (MMS 01006). | $94,000 | $0 | $94,000 |
| Replace 14-foot rotary mower (MMS 01007). | $14,000 | $0 | $14,000 |
| Replace 16-inch high volume lift pump (MMS 01008). | $8,000 | $0 | $8,000 |
| Replace 1996 4X4 Ford tractor (MMS 01010). | $87,000 | $0 | $87,000 |
| Replace 1988 Case 585 tractor (MMS 01011). | $47,000 | $0 | $47,000 |
| Replace 1998 tilt-bed trailer (MMS 01013). | $9,000 | $0 | $9,000 |
| Replace 1991 15-ton tilt-bed trailer (MMS 01012). | $16,000 | $0 | $16,000 |
| Replace 1996 4X4 Dodge Dakota (MMS 01014). | $33,000 | $0 | $33,000 |

| Project Description | Costs | | |
|---|---|---|---|
| Replace 2001 Chevrolet Tahoe (MMS 01016). | $37,000 | $0 | $37,000 |

**Table 33. Cost of projects proposed in Alternative 2 (continued).**

| Project Description | Costs | | |
|---|---|---|---|
| **Equipment Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Replace 1999 Ford F-250 4X4 truck (MMS 01017). | $26,000 | $0 | $26,000 |
| Replace 1998 Ford F-250 4X4 truck (MMS 01018). | $26,000 | $0 | $26,000 |
| Replace 1995 Ford F-250 4X4 truck (MMS 01019). | $26,000 | $0 | $26,000 |
| Replace 1995 Ford F-150 4X4 extended cab truck (MMS 01020). | $29,000 | $0 | $29,000 |
| Replace 18-foot boat, 60-horsepower outboard motor, and trailer (MMS 02004). | $13,000 | $0 | $13,000 |
| Replace 2001 John Deere 670CH Motor Grader (MMS 02005). | $157,000 | $0 | $157,000 |
| Replace 2001 Kubota M8200 tractor (MMS 02006). | $47,000 | $0 | $47,000 |
| Replace 2001 Alamo side mower (MMS 02007). | $8,000 | $0 | $8,000 |
| Replace 2001 Ingersoll-Rand RT 706H forklift (MMS 02008). | $42,000 | $0 | $42,000 |
| Replace 1991 Chevrolet fire engine (MMS 02009). | $84,000 | $0 | $84,000 |
| Replace 20-foot boat, 70-horsepower outboard motor, and trailer (MMS 02011). | $16,000 | $0 | $16,000 |
| Replace 2003 Ford F250 extended cab truck (MMS 04001). | $28,000 | $0 | $28,000 |
| Replace 2003 Freightliner 6X4 stake bed dump truck (MMS 04002). | $70,000 | $0 | $70,000 |
| **Total for Equipment Projects** | **$1,262,000** | **$0** | **$1,262,000** |

**Table 33. Cost of projects proposed in Alternative 2 (continued).**

| Project Description | Costs | | |
|---|---|---|---|
| **Facility Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Resurface Mackay Island Road (MMS 94001). | $342,000 | $0 | $342,000 |
| Replace bulkhead at Bulls Bay with pilings and signs (MMS 95004). | $129,000 | $0 | $129,000 |
| Replace bulkhead at Bellows Bay with pilings and signs (MMS 95005). | $169,000 | $0 | $169,000 |
| Resurface Long Dike (MMS 96003). | $1,082,000 | $0 | $1,082,000 |
| Rehabilitate fire cache (MMS 96005). | $51,000 | $0 | $51,000 |
| Resurface Mackay Island Road (MMS 96008). | $514,000 | $0 | $514,000 |
| Construct observation platform and fishing pier (MMS 97003 – Old RONS)). | $31,000 | $0 | $31,000 |
| Replace office bulkhead (MMS97006). | $37,000 | $0 | $37,000 |
| Repair parallel dike at East Pool (MMS 97007). | $32,000 | $0 | $32,000 |
| Construct observation/photography blind. (MMS 97007 – Old RONS). | $31,000 | $0 | $31,000 |
| Repair Long Dike (MMS 99002). | $135,000 | $0 | $135,000 |
| Construct addition to fire management facilities (MMS 00008). | $80,000 | $0 | $80,000 |
| Rehabilitate office entrance road (MMS 00011). | $131,000 | $0 | $131,000 |
| Construct an additional bay to shop facilities (MMS 00015). | $78,000 | $0 | $78,000 |
| Rehabilitate office parking lot (MMS 00016). | $62,000 | $0 | $62,000 |
| Rehabilitate office entrance road (MMS 00017). | $274,000 | $0 | $274,000 |
| Expand Refuge headquarters (MMS 00018). | $334,000 | $0 | $334,000 |
| Replace bulkhead surrounding Mackay Island (MMS 01001). | $814,000 | $0 | $814,000 |
| Replace East Pool pump (MMS 01022). | $40,000 | $0 | $40,000 |
| Resurface Refuge parking lot (MMS 02010). | $42,000 | $0 | $42,000 |
| Re-survey and post proclamation boundary (MMS 02012). | $26,000 | $0 | $26,000 |
| Rehabilitate shop entrance road (MMS 03001). | $95,000 | $0 | $95,000 |
| Rehabilitate Live Oak Point Road (MMS 03002). | $435,000 | $0 | $435,000 |

**Table 33. Cost of projects proposed in Alternative 2 (continued)**

| Project Description | Costs | | |
|---|---|---|---|
| **Facility Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Rehabilitate Hog Pen Point Road (MMS 03003). | $568,000 | $0 | $538,000 |
| Rehabilitate Cross Dike Road (MMS 03004). | $317,000 | $0 | $317,000 |
| Rehabilitate office entrance road (MMS 03005). | $430,000 | $0 | $430,000 |
| Rehabilitate five Refuge parking lots (MMS 03006). | $57,000 | $0 | $57,000 |
| Construct storage building and garage (MMS 03007). | $77,000 | $0 | $77,000 |
| Replace 30-inch pump and bulkhead (MMS 04003). | $60,000 | $0 | $60,000 |
| Replace bunkhouse (MMS 04004). | $38,000 | $0 | $38,000 |
| Replace fire cache/quarters (MMS 04005). | $400,000 | $0 | $400,000 |
| Replace residence entrance road (MMS 04005). | $60,000 | $0 | $60,000 |
| Replace shop building (MMS 04006). | $600,000 | $0 | $600,000 |
| Build a vehicle and equipment wash rack (RONS 00014). | $18,000 | $4,000 | $22,000 |
| **Total for Facility Projects** | **$7,589,000** | **$4,000** | **$7,593,000** |
| **Grand Total** | **$9,517,500** | **$493,600** | **$10,011,100** |

**Table 34. Cost of projects proposed in Alternative 3.**

| Project Description | Costs | | |
|---|---|---|---|
| **Staff Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total Costs** |
| Existing GS-13 manager (55% Mackay Island). | | $219,000 | $219,000 |
| Existing GS-9 assistant manager (65% Mackay Island). | | | |
| Existing GS-9 park ranger (25% Mackay Island). | | | |
| Existing GS-5 office assistant (85% Mackay Island). | | | |
| ExistingWG-10maintenance mechanic (85% Mackay Island). | | | |
| Existing WG-8 equipment operator (60% Mackay Island). | | | |
| Existing GS-5 forestry technician (60% Mackay Island). | | | |
| New GS-9 biologist (RONS 97006) (65% Mackay Island). | $42,250 | $40,950 | $83,200 |
| New GS-9 outdoor recreation planner (RONS 97013) (40% Mackay Island). | $26,000 | $21,200 | $47,200 |
| New GS-7 biological technician (RONS 00013)(55% Mackay Island). | $41,250 | $40,700 | $81,950 |
| New GS-4 clerk (RONS 99004)(55% Mackay Island). | $41,250 | $27,500 | $68,750 |
| New WG-8 maintenance worker (RONS 00019)(55% Mackay Island). | $35,750 | $28,600 | $64,350 |
| New GS-9 fire management specialist (RONS 00009)(60% Mackay Island). | $51,000 | $41,400 | $92,400 |
| New GS-9 assistant manager (Currituck) (RONS 00011)(5% Mackay Island). | $3,250 | $3,450 | $6,700 |
| New GS-7 biological technician (Currituck) (RONS 00001) (10% Mackay Island). | $6,500 | $5,300 | $11,800 |
| New GS-7 park ranger (law enforcement) (Currituck) (RONS 03000)(5% Mackay Island). | $3,200 | $3,550 | $6,800 |
| New WG-7 tractor operator (RONS 97004)(65% Mackay Island). | $84,500 | $36,400 | $120,900 |
| New GS-7 outdoor recreation planner (RONS 00018)(40% Mackay Island). | $26,000 | $19,600 | $45,600 |
| New GS-5 forestry technician (temporary)(65% Mackay Island). | $42,250 | $31,850 | $74,100 |

**Table 34. Cost of projects proposed in Alternative 3 (continued)**

| Project Description | Costs | | |
|---|---|---|---|
| **Staff Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total Costs** |
| New GS-4 clerk (half time) (55% Mackay Island). | $9,625 | $13,750 | $23,375 |
| Total for Staff Projects | $412,875 | $533,250 | $946,125 |
| New GS-4 clerk (half time) (55% Mackay Island). | $9,625 | $13,750 | $23,375 |
| **Total for Staff Projects** | **$412,875** | **$533,250** | **$946,125** |
| | | | |
| **Budget Projects** (Contracts, Research) | | | |
| Complete cultural resource surveys (RONS 97009). | $80,000 | $0 | $80,000 |
| Improve fire management program (RONS 97011). | $81,000 | $2,000 | $83,000 |
| Control exotic phragmites stands (RONS 99001). | $43,000 | $3,000 | $46,000 |
| Complete forest management plans (RONS 99003). | $67,000 | $0 | $67,000 |
| Develop outreach tools (RONS 00002). | $70,000 | $16,000 | $86,000 |
| Research and restore areas affected by goose grazing (RONS 00003). | $60,000 | $0 | $60,000 |
| Monitor water quality parameters (RONS 00005). | $15,500 | $6,500 | $22,000 |
| Enhance migratory bird management (RONS 00006). | $41,000 | $35,000 | $76,000 |
| Conduct fisheries survey (RONS 000010). | $20,000 | $0 | $20,000 |
| **Total for Budget Projects** | **$477,500** | **$62,500** | **$540,000** |
| | | | |
| **Equipment Projects** | | | |
| Replace Chevy Astro van (MMS 97033). | $31,000 | $0 | $31,000 |
| Replace 1989 Blue Dodge pickup truck (MMS 00003). | $28,000 | $0 | $28,000 |
| Replace 1998 airboat (MMS 01002). | $27,000 | $0 | $27,000 |
| Replace D-4 dozer (MMS 01003). | $159,000 | $0 | 4159,000 |
| Replace heavy duty disc (MMS 01004). | $10,000 | $0 | $10,000 |
| Replace backhoe (MMS 01005). | $90,000 | $0 | $90,000 |
| Replace tracked marsh vehicle (MMS 01006). | $94,000 | $0 | $94,000 |

**Table 34. Cost of projects proposed in Alternative 3 (continued)**

| Project Description | Costs | | |
|---|---|---|---|
| **Equipment Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Replace 14-foot rotary mower (MMS 01007). | $14,000 | $0 | $14,000 |
| Replace 16-inch high volume lift pump (MMS 01008). | $8,000 | $0 | $8,000 |
| Replace 1996 4X4 Ford tractor (MMS 01010). | $87,000 | $0 | $87,000 |
| Replace 1988 Case 585 tractor (MMS 01011). | $47,000 | $0 | $47,000 |
| Replace 1991 15-ton tilt-bed trailer (MMS 01012). | $16,000 | $0 | $16,000 |
| Replace 1998 tilt-bed trailer (MMS 01013). | $9,000 | $0 | $9,000 |
| Replace 1996 4X4 Dodge Dakota (MMS 01014). | $33,000 | $0 | $33,000 |
| Replace 2001 Chevrolet Tahoe (MMS 01016). | $37,000 | $0 | $37,000 |
| Replace 1999 Ford F-250 4X4 truck (MMS 01017). | $26,000 | $0 | $26,000 |
| Replace 1998 Ford F-250 4X4 truck (MMS 01018). | $26,000 | $0 | $26,000 |
| Replace 1995 Ford F-250 4X4 truck (MMS 01019). | $26,000 | $0 | $26,000 |
| Replace 1995 Ford F-150 4X4 extended cab truck (MMS 01020). | $29,000 | $0 | $29,000 |
| Replace 18-foot boat, 60-horsepower outboard motor, and trailer (MMS 02004). | $13,000 | $0 | $13,000 |
| Replace 2001 John Deere 670CH Motor Grader (MMS 02005). | $157,000 | $0 | $157,000 |
| Replace 2001 Kubota M8200 tractor (MMS 02006). | $47,000 | $0 | $47,000 |
| Replace 2001 Alamo side mower (MMS 02007). | $8,000 | $0 | $8,000 |
| Replace 2001 Ingersoll-Rand RT 706H forklift (MMS 02008). | $42,000 | $0 | $42,000 |
| Replace 1991 Chevrolet fire engine (MMS 02009). | $84,000 | $0 | $84,000 |
| Replace 20-foot boat, 70-horsepower outboard motor, and trailer (MMS 02011). | $16,000 | $0 | $16,000 |

**Table 34. Cost of projects proposed in Alternative 3 (continued)**

| Project Descriptions | Costs | | |
|---|---|---|---|
| **Equipment Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Replace 20-foot boat, 70-horsepower outboard motor, and trailer (MMS 02011). | $16,000 | $0 | $16,000 |
| Replace 2003 Ford F250 extended cab truck (MMS 04001). | $28,000 | $0 | $28,000 |
| Replace 2003 Freightliner 6X4 stake bed dump truck (MMS 04002). | $70,000 | $0 | $70,000 |
| **Total for Equipment Projects** | **$1,262,000** | **$0** | **$1,262,000** |
| **Facility Projects** | | | |
| Resurface Mackay Island Road (MMS 94001). | $342,000 | $0 | $342,000 |
| Replace bulkhead at Bulls Bay with pilings and signs (MMS 95004). | $129,000 | $0 | $129,000 |
| Replace bulkhead at Bellows Bay with pilings and signs (MMS 95005). | $169,000 | $0 | $169,000 |
| Resurface Long Dike (MMS 96003). | $1,082,000 | $0 | $1,082,000 |
| Rehabilitate fire cache (MMS 96005). | $51,000 | $0 | $51,000 |
| Resurface Mackay Island Road (MMS 96008). | $514,000 | $0 | $514,000 |
| Construct observation platform and fishing pier (MMS 97003 – Old RONS)). | $31,000 | $0 | $31,000 |
| Replace office bulkhead (MMS97006). | $37,000 | $0 | $37,000 |
| Repair parallel dike at East Pool (MMS 97007). | $32,000 | $0 | $32,000 |
| Construct observation/photography blind. (MMS 97007 – Old RONS). | $31,000 | $0 | $31,000 |
| Repair Long Dike (MMS 99002). | $135,000 | $0 | $135,000 |
| Construct addition to fire management facilities (MMS 00008). | $80,000 | $0 | $80,000 |
| Rehabilitate office entrance road (MMS 00011). | $131,000 | $0 | $131,000 |
| Construct an additional bay to shop facilities (MMS 00015). | $78,000 | $0 | $78,000 |
| Rehabilitate office parking lot (MMS 00016). | $62,000 | $0 | $62,000 |
| Rehabilitate office entrance road (MMS 00017). | $274,000 | $0 | $274,000 |
| Expand Refuge headquarters (MMS 00018). | $334,000 | $0 | $334,000 |
| Replace bulkhead surrounding Mackay Island (MMS 01001). | $814,000 | $0 | $814,000 |

**Table 34. Cost of projects proposed in Alternative 3 (continued)**

| Project Description | Costs | | |
|---|---|---|---|
| **Facility Projects** | **First Year or One Time Costs** | **Recurring Costs** | **Total First Year Costs** |
| Replace East Pool pump (MMS 01022). | $40,000 | $0 | $40,000 |
| Resurface Refuge parking lot (MMS 02010). | $42,000 | $0 | $42,000 |
| Re-survey and post proclamation boundary (MMS 02012). | $26,000 | $0 | $26,000 |
| Rehabilitate shop entrance road (MMS 03001). | $95,000 | $0 | $95,000 |
| Rehabilitate Live Oak Point Road (MMS 03002). | $435,000 | $0 | $435,000 |
| Rehabilitate Hog Pen Point Road (MMS 03003). | $568,000 | $0 | $568,000 |
| Rehabilitate Cross Dike Road (MMS 03004). | $317,000 | $0 | $317,000 |
| Rehabilitate office entrance road (MMS 03005). | $430,000 | $0 | $430,000 |
| Rehabilitate five Refuge parking lots (MMS 03006). | $57,000 | $0 | $57,000 |
| Construct storage building and garage (MMS 03007). | $77,000 | $0 | $77,000 |
| Replace 30-inch pump and bulkhead (MMS 04003). | $60,000 | $0 | $50,000 |
| Replace bunkhouse (MMS 04004). | $38,000 | $0 | $38,000 |
| Replace fire cache/quarters (MMS 04005). | $400,000 | $0 | $400,000 |
| Replace residence entrance road (MMS 04005). | $60,000 | $0 | $60,000 |
| Replace shop building (MMS 04006). | $600,000 | $0 | $600,000 |
| Build a vehicle and equipment wash rack (RONS 00014). | $18,000 | $4,000 | $22,000 |
| **Total for Facility Projects** | **$7,589,000** | **$4,000** | **$7,593,000** |
| **Grand Total** | **$9,741,375** | **$599,750** | **$10,341,125** |

*EDUCATION AND VISITOR SERVICES*

As the visitor services program develops, the staff would continue to assess the program and its potential impact on refuge resources. The refuge would change the program as needed to address any impacts identified and to respond to anticipated wildlife population increases. To ensure a quality wildlife-dependent recreation experience while achieving the "wildlife first" mandate, the Service would limit the number of users and conflicts among users by the following: (1) permitting uses; (2) designating roads, trails, and sites for specific kinds of wildlife-dependent recreational use; and (3) permitting uses at certain times of the year.

There are a number of situations that may warrant future refuge closures or restrictions on access. Examples of these situations include, but are not limited to, the following: protection of endangered species; protection of nesting birds and bear den sites; restriction of recreation activities to achieve specific wildlife population objectives; minimization of conflicts with other refuge management programs; and limitations from inadequate funds and/or staff to administer use.

**PROPOSED ACTION**

The staff selected management Alternative 2 as the preferred alternative for the proposed comprehensive conservation plan for managing Mackay Island National Wildlife Refuge over the next 15 years. Alternative 2 meets all the goals of the refuge in wildlife and habitat management, but is not as extensive in public use and resource protection as Alternative 3. Alternative 2 does propose to increase the size of the refuge staff and increase the number of visitors for various public uses from 33 percent for uses that are currently popular to 250 percent for uses that currently have limited opportunities.

When it is separated from the environmental assessment portion of this combined Draft Comprehensive Conservation Plan and Environmental Assessment, the final plan will include the goals, objectives, and strategies listed for Alternative 2. The staff will use those goals, objectives, and strategies to achieve the refuge vision.

The planning team evaluated two other alternatives for managing the refuge. The other alternatives evaluated were *Alternative 1 - No Action*, and *Alternative 3*. This section of the draft plan describes Alternative 2.

Implementing the proposed alternative would result in better habitat management and increased public use opportunities, while meeting the refuge's primary purpose of protecting habitat for migratory birds. Specific results would include increased songbird and wood duck use and production; enhanced habitat and increased protection for other forest interior-dependent wildlife; enhanced resident wildlife populations; optimum wetland condition within a managed flow situation; and greater opportunities for a variety of compatible wildlife-dependent recreational and environmental education activities.

An overriding concern reflected in this plan is that wildlife conservation is the first priority in refuge management. The Service allows public uses if they are compatible and appropriate with wildlife and habitat conservation. It emphasizes wildlife-dependent public uses (hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation).

Under this alternative, the Service would protect, maintain, restore, and enhance refuge lands for resident wildlife, waterfowl, migratory nongame birds, and threatened and endangered species. The staff would initiate extensive wildlife and plant census and inventory activities to develop the baseline biological information needed to implement management programs.

The staff would direct all management actions towards achieving the refuge's primary purposes: (1) preserving nesting and migratory habitat for neotropical migratory songbirds; (2) providing production habitat for wood ducks; and (3) helping to meet the habitat conservation goals of the North American Waterfowl Management Plan. In addition, the staff would manage the refuge to contribute to other national, regional, and state goals for protecting and restoring populations of wildlife.

The Service would implement active habitat management through forest management and impoundment management designed to provide a historically diverse complex of habitats that meets the foraging, resting, and breeding requirements for a variety of species.

Under this alternative, the refuge would continue to seek acquisition of all willing-seller inholdings within the present acquisition boundary. The primary purpose for this acquisition is to provide a coastal marsh and forest system of sufficient size and carrying capacity to reach regional objectives associated with area-sensitive neotropical birds, anadromous fish, forest-associated waterfowl, and wetland forest landscapes. Lands acquired as part of the refuge would be available for compatible wildlife-dependent recreation and environmental education.

During the 15-year life of this plan, the refuge staff would develop and implement a forest management plan, designed to create spatially and specifically diverse hardwood forest (with little negative effect to waterfowl objectives).

The Service would provide opportunities for quality wildlife-dependent recreation (hunting, fishing, wildlife observation and photography) and environmental education and interpretation activities. The refuge would improve the access roads to ensure all-weather vehicular access to a broad segment of the public. The staff would permit hiking to support wildlife-dependent recreation to the extent that these opportunities do not substantially interfere or detract from the achievement of wildlife conservation. They would provide wildlife observation sites and platforms; interpretive trails, boardwalks, and kiosks; and restrooms at specific sites to allow for fully accessible environmental education and interpretation programs. The plan provides for quality fishing and hunting programs, consistent with sound biological principles with sufficient focus on migratory bird needs for sanctuary, loafing, feeding, and courting requirements. The Service would permit fishing along the banks of the bays and sounds and its impoundments. The staff would develop and implement an environmental education plan, incorporating an aggressive and proactive promotion of both on- and off-site programs.

*COMPATIBLE SECONDARY USES*

The National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, states that the Service must protect national wildlife refuges from incompatible or harmful human activities to ensure that Americans enjoy Refuge System lands and waters. Before the Service allows activities or uses on a national wildlife refuge, the staff must find the uses to be compatible. A compatible use does not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge. The refuge may authorize wildlife-dependent recreational uses when they are compatible and not inconsistent with public safety.

An interim compatibility determination is a document that assesses the compatibility of an activity during the period of time the Service first acquires a parcel of land to the time a formal, long-term management plan for that parcel is prepared and adopted. The Service has completed an interim compatibility determination for the six priority general public uses of the system, as listed in the National Wildlife Refuge System Improvement Act. These uses are hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation.

*OTHER MANAGEMENT*

The staff would conduct all management activities that could affect natural resources, including subsurface mineral reservations, utility lines and easements, soil, water and air, and historical and archaeological resources to comply with all laws and regulations. The Service has a legal responsibility to consider the effects of its actions on cultural resources. Under all alternatives, the Service would manage these resources in accordance with public law and agency policy. Individual projects would require additional consultation with the Advisory Council on Historic Preservation and the State of North Carolina's Historic Preservation Office. The Service would require additional consultation, surveys, and clearance when project development is on the refuge or when activities would affect properties that are listed or eligible for listing on the National Register of Historic Places.

# IV. Environmental Consequences

This section analyzes and discusses the potential environmental effects or consequences that the implementation of each of the three management alternatives described in Section III of this environmental assessment would cause. The planning team selected the following impact topics for analysis: effects on fish and wildlife populations, effects on habitats, effects on public use, effects on resource protection and conservation, and effects on general administration. They chose these topics based on the important issues and concerns raised at the public scoping meetings and the planning team meetings. Each alternative portrays the expected outcomes for fish and wildlife species through 2019, varying as to the intensity of management. Table 36 outlines a comparison of the effects of Alternatives 2 and 3 to the existing condition (Alternative 1).

## COMPARISON OF EFFECTS AMONG ALTERNATIVES

### *OVERVIEW*

The refuge's current management actions described in Alternative 1, such as its water management, prescribed burning, and deer hunting program, and its present efforts to acquire in-holdings within the present refuge acquisition boundary, would have minimal to no effects on the biological or socioeconomic environment. The proposed management actions described in Alternative 2, such as monitoring wider range of wildlife species; developing programs for interpretation, environmental education, wildlife observation, and photography; and acquiring private property from willing sellers would have slightly positive effects on the biological environment and society. The proposed management actions described in Alternative 3, such as more surveying wildlife species and habitats, managing habitats, implementing a habitat management plan and developing enhanced environmental education and wildlife observation programs, would have moderately positive effects on the biological environment and society. Implementation of Alternatives 2 and 3 would produce new economic opportunities from the salaries of the new staff, refuge expenditures in the local economy, and refuge visitors participating in outdoor recreation and environmental education opportunities.

### *BIOLOGICAL ENVIRONMENT*

Each alternative would protect existing habitat important to migratory birds, mammals, reptiles, amphibians, fish, and invertebrates. Alternative 1 provides data on waterfowl and maintains habitat in fire-dependent ecosystems with prescribed burning. Alternative 2 would provide data on more species on the refuge and management of all habitats on the refuge. Alternative 3 would provide data on all species on the refuge and management of all habitats on the refuge.

Habitat for all species would show moderate improvement under Alternatives 2 and 3 because of the improved habitat management. The improved management would extend beyond the current prescribed burning by monitoring the effects of the burning and adapting fire frequency and timing to produce better results. It would also introduce canopy management in forests to provide better habitat in stands that have high canopy densities.

The staff currently controls pest plants and animals as it has time and funding permits. They would develop an integrated pest management plan under Alternatives 2 and 3. Whenever possible, all alternatives would use techniques other than pesticides to control these species. However, the staff would use some quantity of pesticides on an as-needed basis. Pest management plans would also

prescribe pest monitoring and control methods and reduce habitat loss to pest plants and animals. There is no change in the net effect on the pest populations, but the staff would efficiently plan control measures and document the effects of the control on habitats and wildlife populations.

The increased public use provided in Alternatives 2 and 3 may negatively affect the refuge's wildlife populations due to disturbance and habitat trampling. Under all public use alternatives, the plan would concentrate the level of recreation use and ground-based disturbance from pedestrians on boardwalks, trails, and the refuge's office and maintenance areas. Despite this and dispersed activities, including hunting, public use could still have a negative effect on nesting bird populations. It is unlikely that species such as bald eagles would establish nests near developed facilities.

However, improved habitat monitoring and prompt response to deterioration by restricting access should minimize the effects. The negative effects would be temporary and would be mitigated by corrective actions and an overall improvement in habitat condition.

There is one known bald eagle nest on the refuge. Bald eagles are vulnerable to human activity around nesting areas and do not tolerate human disturbances during the breeding season. Recreational activities, including hiking, hunting, and small fishing craft, could be a major disturbance to bald eagles. The refuge currently restricts access to the area of the eagle nest during nesting season. That practice would continue with Alternatives 2 and 3. The level of recreational use is least disturbing to wildlife under Alternative 1, and most disturbing under Alternatives 2 and 3. The level of recreational use expected under Alternatives 2 and 3 include disturbances related to hiking, hunting, and fishing and could preclude the possibility of eagles establishing a nest where most of the proposed recreational activities would occur. Hunting is primarily a winter season activity and should not affect the eagles. The expansion of habitat management activities described in Alternatives 2 and 3 may also negatively affect bald eagles locating on the refuge over the short term. Over the long term, Alternatives 2 and 3 would produce a number of suitable nesting and roosting trees for bald eagles.

The deer population on the refuge is currently at a healthy carrying capacity. Under Alternatives 2 and 3, habitat management actions could increase the deer population. The refuge's natural habitats and croplands and adjacent croplands provide rich sources of forage for deer. Under all alternatives, the staff would monitor deer populations and use hunting to manage their populations in order to provide a compatible recreational activity and prevent habitat damage. Hunting would also ensure the health of the deer herd and minimize the effects to other wildlife species and habitat.

Each alternative would protect sites important to migrating waterfowl, shorebirds, wading birds, and land birds. The increases in staffing, buildings, and equipment in Alternatives 2 and 3 have the potential to increase the refuge's management capabilities to support the proposed program improvements.

All alternatives would provide additional protection to wetlands beyond the protection afforded by existing wetland regulations through land acquisition from willing sellers within the approved acquisition boundary. They would also protect landscape characteristics, such as habitat connectivity, and would provide sufficient proprietary interest in properties to restore habitats for wildlife. The proposed management of new acquisitions would provide larger areas for habitat protection and management.

*PHYSICAL ENVIRONMENT*

The most critical issue is the water quality in the rivers, bays, and sounds surrounding the refuge. The water in the sounds and bays has changed over the years from brackish to almost fresh in nature as natural inlets closed and tidal influences decreased. Non-point pollution has decreased water quality over the years. Submerged aquatic vegetation has also decreased. The submerged aquatic vegetation provides the food for the fish and diving ducks that made Currituck County famous as a "Sportsmen's Paradise."

None of the alternatives in this plan address the water quality from sources off the refuge since the Service has no jurisdiction off the refuge. All the alternatives mandate the management of the refuge to minimize water pollution. None of the alternatives would change the water quality in individual streams and wetlands due to a relatively low level of soil disturbance and fertilizer and pesticide application. The management of natural habitats would maintain groundwater recharge and minimize runoff sedimentation, and non-point source pollution. The net effect would be no change from Alternative 1 to 2 to 3.

The refuge uses relatively little water from groundwater or surface water sources. The staff pumps water from the Currituck Sound to the impoundments in the fall and pumps it back into the Sound in the spring. Cooperative farmers grow crops without irrigation. There is no difference in water use among the proposed alternatives. The net effect would be no change from Alternative 1 to 2 to 3.

All alternatives would positively affect soil formation processes on lands the refuge acquires by maintaining perennial natural vegetation on most of the refuge's area. Some temporary disturbances to surface soils and topography would occur at those locations selected for administrative and public use facilities, maintenance operations, and habitat management. In the long term, the improvements in habitat will mitigate the temporary disturbances and compaction by improving the permeability of the soil. The net effect would be no change from Alternative 1 to 2 to 3.

Each alternative would protect the aesthetic characteristics associated with natural habitats. The staff would carry out habitat management activities designed to improve forest composition and structure in such a way to minimize any short- term aesthetic effects. The management would maintain or increase plant diversity in each community and the diversity of the wildlife species that inhabit them. The net effect would be no change from Alternative 1 to 2 to 3.

*SOCIAL ENVIRONMENT*

Alternative 1 concentrates on providing opportunities for hunting. The North Carolina Wildlife Resources Commission sets statewide seasons and bag limits. The refuge permits hunting when staff is available to administer the hunt and provide law enforcement. The refuge allows the other priority public uses (fishing, environmental education, interpretation, wildlife observation, wildlife photography), but does not provide programs to support them. The staff conducts environmental education as requested and participates in major local outreach events.

Visitor use management on refuge concentrates on the experience, not the number of people coming into a refuge. The types and intensity of visitor activities would vary from one habitat to another depending on its size, habitat type(s), and wildlife uses. Because much of the land in Currituck County is currently in private ownership, the general public realizes only minimal access privileges on that land. As the Service acquires more land and places it in the public trust, more opportunities for public access would become available.

The wildlife-dependent recreational activities described under Alternatives 2 and 3 (i.e., expanded opportunities for hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation) would increase visitation to the refuge, add to the local social environment, and generate greater purchases of local goods and services in the economy of the surrounding communities. An estimated 70,000 visits to the refuge were reported in 2000.

Refuge visitation to support priority public uses would generally build over time as the Service hires a public use specialist, develops visitor service programs and facilities, provides operational funds, and acquires more land. Initially, much of the public use on the refuge will come from local, county, and state residents, and tourists visiting the area for another purpose. The staff predicts an increase in the number of spring and fall tourists for hiking and wildlife observation and photography. Programs developed for school children would either bring the children to the refuge or knowledge of the refuge wildlife and habitats to area schools. The number of visitors would depend on the season and would grow as the refuge land base increases and the staff provides more public use programs. The total effect of the program proposed in Alternative 2 should have a slightly positive effect on refuge visitors; Alternative 3 should have a moderately positive effect.

*ECONOMIC ENVIRONMENT*

Many of the wildlife-dependent recreational activities offered have yet to be discovered by local citizens. As a generator of economic benefits, each alternative identifies hunting and wildlife observation as important tourist attractions. Under Alternatives 2 and 3, development of wildlife-dependent recreation programs and facilities and improved publicity would lead to the greatest economic benefit from increased tourism. Local visitors and avid birdwatchers may come to the refuge as a separate trip, but tourists would more likely come to the refuge as an addition to their vacation in other parts of the area. The current 70,000 visitors for wildlife observation represent $7 million in expenditures in the local economy at an estimated $100 per visitor day (Vogelsang 2001)). The additional 20,000 visitors estimated in Alternative 2 will have a slightly positive effect ($2 million) on the local economy; the additional 30,000 visitors estimated in Alternative 3 will have a moderately positive effect ($3 million).

The proposed levels of funding would vary greatly from Alternative 1 to 2 to 3. Alternative 1 would have a recurring annual funding of $244,500; there would be $8,961,500 in first-year or one-time funding as the Service hires employees, buys equipment, constructs buildings, or repairs roads. Alternative 2 would have a recurring annual funding of $493,600; there would be $9,517,500 in first-year or one-time funding as the Service hires employees, buys equipment, constructs buildings, or repairs roads. Alternative 3 would have a recurring annual funding of $599,750; there would be $9,741,375 in first-year or one-time funding as the Service hires employees, buys equipment, constructs buildings, or repairs roads. The added expenditures of Alternative 2 would have a slightly positive effect on the local economy; Alternative 3 would have a moderately positive effect.

Land acquisition within the approved acquisition boundary would decrease the gross property tax revenues of Currituck County. However, there would be an increase in refuge revenue-sharing payments. Because the Service is a federal agency, it is not subject to state and local taxes. Under the Refuge Revenue Sharing Act, the Fish and Wildlife Service would make annual payments to the counties to offset the loss of property tax revenues. These annual refuge revenue-sharing payments for owned and acquired lands are computed on whichever of the following formulas is greatest: (1) three-fourths of 1 percent of the fair market value of the lands acquired in fee title; (2) 25 percent of the net refuge receipts collected; or (3) 75 cents per acre of the lands acquired in fee title within the counties. The Refuge Revenue Sharing Act also requires that Service lands be appraised every five years to ensure that payments to local governments remain equitable. In 2004, Currituck County received a revenue-sharing

payment of $21,131 for 7,345 acres ($2.96 per acre) with an appraised value of $6,046,892 at Mackay Island National Wildlife Refuge. This was only 47 percent of the amount due to the county under the Revenue Sharing Act. Congress did not appropriate sufficient funding to pay the full amount. If fully funded, revenue sharing would have paid $45,352 to the county.

The State of North Carolina recommends that counties tax undeveloped land based on the present use of the land. The state publishes a use-value manual based on the area of the state (Major Land Resource Area or MLRA) and the soil series of the land. Mackay Island National Wildlife Refuge is in the Tidewater area (MLRA 153B) and has 4,800 acres of soils rated as unproductive, 170 acres of Class I soil in cropland, and 88 acres of Class II soil in cropland, 1,391 acres of Class I soil in forest, and 691 acres of water (Table 35). The county tax rate is $.70 per $100 of assessed value. The county would have taxed $1,156,370 of assessed value $8,095 if the 7,345 acres ($1.10 per acre) of land were privately owned.

The Revenue-Sharing Act payment of $21,131 is more than twice the state-recommended tax of $8,095. The Service will contribute revenue-sharing payments to all new acquisitions.

**Table 35. North Carolina present use value calculation.**

| Soil | Acreage | Class | Value/Acre | Total Value |
|---|---|---|---|---|
| Currituck | 4,800 | VI (Unproductive) | $40 | $192,000 |
| Altavista | 100 | I (Cropland) | $1200 | $204,000 |
| State | 70 | | | |
| Total | 170 | | | |
| Dragston | 88 | II (Cropland) | $1010 | $88,880 |
| Augusta | 45 | II (Forest) | $290 | $59,450 |
| Bojac | 110 | | | |
| Conetoe | 50 | | | |
| Total | 205 | | | |
| Roanoke | 1,311 | I (Forest) | $440 | $612,040 |
| Nimmo | 65 | | | |
| Wahee | 10 | | | |
| Munden | 5 | | | |
| Total | 1,391 | | | |
| Water | 691 | No Class | $0 | $0 |
| **Total** | **7,345** | | | **$1,156,370** |

**Table 36. A comparison of the effects of Alternatives 2 and 3 to Alternative 1.**

| Area of Concern | Alternative 2 | Alternative 3 |
|---|---|---|
| **Effect on Biological Environment** | | |
| Fish Population | Slight Increase | Slight Increase |
| Invertebrate Population | Slight Increase | Slight Increase |
| Land Bird Population | Moderate Increase | Moderate Increase |
| Mammal Population | Moderate Increase | Moderate Increase |
| Reptile and Amphibian Population | Slight Increase | Slight Increase |
| Shorebird Population | Slight Increase | Slight Increase |
| Wading Bird Population | No Change | No Change |
| Waterfowl Population | No Change | No Change |
| Pest Animal Populations | No Change | No Change |
| Wildlife Disease Level | No Change | No Change |
| Conditions of All Habitats | Moderate Improvement | Moderate Improvement |
| Natural Heritage Area Condition | No Difference | No Difference |
| Coastal Fringe Evergreen Forest Habitat Conditions | Moderate Improvement | Moderate Improvement |
| Mesic Pine Flatwoods Conditions | Moderate Improvement | Moderate Improvement |
| Brackish Marsh Conditions | No Change | No Change |
| Pest Plant Populations | No Change | No Change |
| **Effect on Physical Environment** | | |
| Soil Erosion | No Change | No Change |

**Table 36. A comparison of the effects of Alternatives 2 and 3 to Alternative 1 (continued)**

| Area of Concern | Alternative 2 | Alternative 3 |
|---|---|---|
| **Effect on Physical Environment** | | |
| Soil Compaction | No Change | No Change |
| Water Quality | No Change | No Change |
| Water Quantity | No Change | No Change |
| Water Quantity | No Change | No Change |
| Aesthetics | No Change | No Change |
| Area of Concern | Alternative 2 | Alternative 3 |
| **Effect on Social Environment:** | | |
| Hunting | Slight Improvement | Slightly Positive |
| Fishing | Slight Improvement | Moderate Improvement |
| Environmental Education | Slight Improvement | Moderate Improvement |
| Interpretation | Moderate Improvement | Moderate Improvement |
| Wildlife Observation | Slight Improvement | Moderate Improvement |
| Wildlife Photography | Slight Improvement | Moderate Improvement |
| Outreach | Slight Improvement | Moderate Improvement |
| Cultural Resources | No Change | No Change |
| **Effect on Economic Environment** | | |
| Local Expenditures | Slight Increase | Moderate Increase |
| Local Property Taxes | No Change | No Change |

## EFFECTS COMMON TO ALL ALTERNATIVES

### *HEALTH AND SAFETY EFFECTS*

None of the alternatives would have a significantly negative effect on public health and safety. The only potential safety problems involve the possibility of boat accidents of visitors gaining access to the refuge by water, hiking accidents occurring on the refuge's roads and trails, and accidents occurring during the hunting season. As indicated below in the mitigation/minimization section, national wildlife refuges have used time and space zoning successfully to minimize the possibility of potential accidents and conflicts between hunters and other refuge user groups.

### *REGULATORY EFFECTS*

As indicated in the Background section of the Comprehensive Conservation Plan, the Service must comply with a number of federal laws, administrative orders, and policies in the development and implementation of its management actions and programs. Among these mandates are the Endangered Species Act of 1973, the Clean Water Act of 1977 and compliance with Executive Orders 11990 (Protection of Wetlands) and 11988 (Floodplain Management). The implementation of any of the alternatives described in this environmental assessment would not lead to a violation of these or other mandates.

### *UNCERTAINTY OF FUTURE ACTION EFFECTS*

The refuge has little detailed data on its resources beyond waterfowl populations and the condition of moist-soil units in the impoundments. In general, one of the most important components of each alternative is the inventory and monitoring of fish and wildlife populations and habitats on the refuge. Once this information is known, the Service would develop detailed step-down management plans to manage the fish and wildlife populations and habitats, based on the application of sound fish and wildlife management principles and concepts. The specific content of the step-down management plans would provide the basis for further analysis of environmental effects.

The alternatives in this plan do not present sufficient information to assess the full potential environmental effects of plans to be developed in the future.

### *CUMULATIVE EFFECTS*

Cumulative effects on the environment result from incremental effects of a proposed action when these are added to other past, present, and reasonably foreseeable future actions. While cumulative effects may result from individually minor actions, they may, viewed as a whole, become significant over time.

The implementation of any of the three alternatives described in this document includes actions relating to site development, fish and wildlife habitat and population management, land acquisition, and recreational use programs. These actions would have both direct and indirect effects (e.g., site development would result in increased public use, thus increasing littering, noise, and vehicular traffic). Many of these effects would be temporary and would be minimal in light of the long-term benefits to habitat conditions, wildlife populations, and the social and economic environment on and around the refuge. Each action would have mitigation to minimize the individual actions and thus the cumulative effects of a series of actions. The measures listed in the next section outline that mitigation. However, the cumulative effects of these actions over the 15-year planning period are not expected to be significant.

## CULTURAL RESOURCES

All alternatives afford additional land protection and low levels of development, thereby producing little negative effect on the refuge's cultural and historic resources. Potentially negative effects could include logging and construction of new trails. These management actions would require review by the Service's Regional Cultural Resource Officer in consultation with the State of North Carolina's Historic Preservation Office, as mandated by Section 106 of the National Historic Preservation Act. Therefore, the determination of whether a particular action within an alternative has the potential to affect cultural resources is an on-going process that would occur during the planning stages of every project.

Service acquisition of land with known or potential archaeological or historical sites provides two major types of protection for these resources--protection from damage by federal activity and protection from vandalism or theft. The National Historic Preservation Act requires that the State Historic Preservation Office review any actions by a federal agency that may affect archaeological or historical resources, and that the agency must avoid or mitigate identified effects. The Service's policy is to preserve these cultural, historic, and archaeological resources in the public trust, and avoid any adverse effects wherever possible.

Land acquisition by the Service would provide some degree of protection to important cultural and historic resources. If acquisition of private lands does not occur and these lands remain under private ownership, the landowner would be responsible for protecting and preserving cultural resources. Development of off-refuge lands has the potential to destroy archaeological artifacts and other historical resources, thereby decreasing opportunities for cultural resource interpretation and research.

## ENVIRONMENTAL JUSTICE

The decision-making process used in developing this plan and environmental assessment followed the procedures in the National Environmental Policy Act (NEPA). The Service conducted public meetings in the area served by the refuge, advertised the planning and process and the meetings in the print media and with posters in government offices and business establishments. Management of the refuge is not intensive and does not involve the use of hazardous substances. The management practice with the most potential for environmental harm is prescribed burning. The Service uses prescriptions developed by the State of North Carolina to minimize the effects of smoke on human health. The hazards presented by the smoke are distributed equally among all residents of the area.

## WATER QUALITY, WWETLANDS, AND FLOODPLAINS

The water quality in the waters surrounding the refuge is only fair due to the abundance of organic matter in the soil through which the water drains (page 26, Table 6). None of the proposed actions in this plan should reduce that water quality. The majority of the refuge is classified as wetlands (page 22, Table 4). The Service will apply for the appropriate permits from the federal and state agencies that regulate wetlands before starting any development on the refuge. The Service will avoid or minimize and disturbance to wetlands in its development process. The majority of the refuge also floods on a regular basis with the tides. The major activity in the areas subject to flooding will be prescribed burning, waterfowl hunting, and wildlife surveys in the marsh. None of these activities have impacts on the frequency or extent of flooding.

## PUBLIC HEALTH AND SAFETY EFFECTS

None of the three alternatives would have a significantly negative effect on public health and safety. The only potential safety problems involve the possibility of hiking accidents occurring on the refuge's trails, and accidents occurring during the hunting season. As indicated below in the mitigation/minimization section, the Service has used time and space zoning successfully on national wildlife refuges to minimize the possibility of potential accidents and conflicts between hunters and other refuge user groups.

## REFUGE REVENUE SHARING

The Refuge Revenue Sharing Act provides for the Fish and Wildlife Service to make annual payments to the counties to offset the loss of property tax revenues. The Service computes these annual refuge revenue-sharing payments for owned and acquired lands on whichever of the following formulas is greatest: (1) three-fourths of 1 percent of the fair market value of the lands acquired in fee title; (2) 25 percent of the net refuge receipts collected; or (3) 75 cents per acre of the lands acquired in fee title within the counties. The Refuge Revenue Sharing Act also requires that the Service appraise its lands every five years to ensure that payments to local governments remain equitable.

## MITIGATION MEASURES

Described below are the measures used to mitigate and minimize the potential adverse effects.

### *WILDLIFE DISTURBANCES*

Disturbance to wildlife at some level is an unavoidable consequence of any public use program, regardless of the activity involved. Obviously, some activities innately have the potential to be more disturbing than others. The refuge staff has carefully planned all of the proposed alternative public use activities contained in this document to avoid unacceptable levels of impact.

As currently proposed, the known and anticipated level of disturbance of the proposed alternative (Alternative 2) is not considered significant and is well within the tolerance level of known wildlife species and populations present in the area. Implementation of the proposed public use program would take place through carefully controlled time and space zoning, including the management of waterfowl sanctuary areas, establishment of protection zones around key sites such as rookeries and eagle nests, and the routing of roads and trails to avoid contact with sensitive areas such as rookery habitats, etc. In addition, the refuge would conduct all public hunting activities (e.g., season lengths, bag limits, number of hunters) within the constraints of sound biological principles and refuge-specific regulations established to restrict illegal or non-conforming activities. Providing fishing opportunities would allow the use of a renewable natural resource without adversely impacting other resources. The North Carolina Wildlife Resources Commission sets the fishing seasons and bag and creel limits enforced on the refuge. Refuge hunts are held within the seasons set by the North Carolina Wildlife Resources Commission.

General wildlife observation/photography activities may result in minimal disturbances to wildlife. If visitors venture too close to foraging songbirds, waterfowl, wading birds, or other wildlife, disruption of foraging or resting activities could result in more severe disturbances. To mitigate these potential disturbances, the Service would design and construct all visitor trails and observation points with a buffer around key wildlife forage and resting areas. The staff would educate the visitors through signs and brochures to avoid disturbing wildlife. Also, the Service may close any area on the refuge to the public if disturbance becomes excessive. Temporary initial disturbances to wildlife and habitat would occur during the construction of new facilities, such as trails, wildlife observation platforms, photo blinds, and interpretive sites. However, once the construction of such facilities is completed, the experience gained by the public would offset these disturbances. Allowing these non-

consumptive recreational opportunities on the refuge will help to maintain and build public support for the refuge and the Roanoke-Tar-Neuse-Cape Fear ecosystem.

The Service would monitor the impacts of activities through wildlife inventories and assessments of public use levels and activities. The staff would adjust public use programs as needed to limit disturbance to acceptable levels.

*USER GROUP CONFLICTS*

As public use levels expand across time, unanticipated conflicts between user groups may occur. The staff would adjust the refuge's public use programs as needed to eliminate or minimize each problem and provide quality wildlife-dependent recreational opportunities. Experience has proven that time and space zoning (e.g., establishment of separate use areas, use periods, and restrictions on the number of users) is an effective tool in eliminating conflicts between user groups. The current practice of discouraging all public uses except hunting during hunting season would continue.

*EFFECTS ON ADJACENT LANDOWNERS*

Implementation of the proposed action would not impact adjacent or in-holding landowners. The plan allows essential access to private property through the issuance of special use permits. Future land acquisitions would occur on a willing-seller basis only and at fair market values. In addition, under the preferred alternative of the proposed comprehensive conservation plan, the staff would conduct water quality sampling and monitoring activities to document current conditions and seek to improve the water quality, if necessary. Existing state water quality criteria and use classifications are adequate to achieve desired on-refuge conditions. Thus, implementation of the proposed alternative would not impact adjacent landowners or users beyond the constraints already implemented under existing state standards and laws. Prescribed burning would minimize the threat of wildfire to adjacent landowners from the refuge marshes or forests.

*LAND OWNERSHIP AND SITE DEVELOPMENT*

Land acquisition within the approved acquisition boundary would result in changes in land and recreational use patterns, since all uses on national wildlife refuges must meet compatibility standards. Land ownership by the Service also precludes any future economic development by the private sector on these lands. The land within the approved acquisition boundary is subject to regulation under the Clean Water Act that would limit development of the land for residential, commercial, industrial, or agricultural use.

Potential development of access roads, buildings, trails, water control structures, visitor parking areas and other improvements could lead to minor short-term negative impacts on plants, soils, and some wildlife species. When the refuge proposes site development activities, each activity would receive the appropriate National Environmental Policy Act consideration during pre-construction planning. At that time, the staff would incorporate any required mitigation activities, if necessary, into the specific project to reduce the level of impacts to the human environment and to protect fish and wildlife and their habitats.

As indicated earlier, one of the direct effects of site development is increased public use; this increased use may lead to more littering, noise and vehicle traffic. While the Service would allocate funding and personnel to minimize these indirect effects of public use, such allocations would make the resources unavailable for other programs such as habitat monitoring or wildlife surveys.

# V. Consultation And Coordination

The Service formed a planning core team composed of representatives from various Service divisions to prepare the Draft Comprehensive Conservation Plan and Environmental Assessment (Table 37). Initially, the team focused on identifying the issues and concerns pertinent to refuge management. The team met on several occasions from December 2000 to June 2002. A biological review team (Table 38) met on the refuges in the ecosystem four times between December 1999 and December 2000 to assess the habitats on the refuges and the needs of wildlife species in the ecosystem, and make recommendations on land management and acquisition needs. The biological review team's recommendations appear in Appendix IX. The core team also sought the contributions of experts (Table 39) from various fields.

**Table 37. Mackay Island National Wildlife Refuge core team members.**

| Name and Title | Station, Agency, and Location |
|---|---|
| Tim Cooper, Project Leader<br>Suzanne Baird, Former Project Leader<br>Kendall Smith, Assistant Manager<br>Mike Panz, Park Ranger<br>Peggy Vanzant, Office Assistant | Mackay Island National Wildlife Refuge<br>Knott's Island, North Carolina |
| Robert Glennon, Natural Resource Planner<br>David Brown, Former Habitat Protection Biologist | Ecosystem Planning Office<br>Fish and Wildlife Service<br>Edenton, North Carolina |

The planning team met in January 2001. Shortly thereafter, on June 19, 21, 26, and 28, 2001, the planning team held a series of public meetings to gain the insights of local citizens and their perceptions of the issues and concerns facing the refuge. The issues and alternatives generated from these meetings, coupled with the input of the planning team, are summarized in Chapters 1 and 3 of this environmental assessment.

**Table 38. Mackay Island National Wildlife Refuge biological review team members.**

| Name and Title | Station, Agency, and Location |
|---|---|
| Bob Noffsinger, Former Supervisory Wildlife Management Biologist | Migratory Bird Field Office,<br>Fish and Wildlife Service,<br>Manteo, North Carolina |
| Frank Bowers, Former Migratory Bird Coordinator | Southeast Regional Office,<br>Fish and Wildlife Service,<br>Atlanta, Georgia |
| Chuck Hunter, Former Nongame Migratory Bird Coordinator | Southeast Regional Office,<br>Fish and Wildlife Service,<br>Atlanta, Georgia |
| Ronnie Smith, Fisheries Biologist | Fisheries Assistance Office<br>Fish and Wildlife Service<br>Edenton, North Carolina |
| John Stanton, Wildlife Biologist | Mattamuskeet National Wildlife Refuge<br>Fish and Wildlife Service<br>Swan Quarter, North Carolina |
| Wendy Stanton, Wildlife Biologist | Pocosin Lakes National Wildlife Refuge<br>Fish and Wildlife Service<br>Columbia, North Carolina |
| Dennis Stewart, Wildlife Biologist | Alligator River National Wildlife Refuge<br>Fish and Wildlife Service<br>Manteo, North Carolina |
| Ralph Keel, Former Wildlife Biologist | Great Dismal Swamp National Wildlife Refuge<br>Fish and Wildlife Service<br>Suffolk, Virginia |
| John Gallegos, Wildlife Biologist | Back Bay National Wildlife Refuge<br>Fish and Wildlife Service<br>Virginia Beach, Virginia |
| David Allen, Nongame Wildlife Biologist | North Carolina Wildlife Resources Commission<br>New Bern, North Carolina |
| Jeff Horton, Site Manager | The Nature Conservancy<br>Windsor, North Carolina |

**Table 39. Expert contributors to the Mackay Island National Wildlife Refuge Comprehensive Conservation Plan and their area(s) of expertise.**

| Name, Title, Agency, Location | Area of Expertise |
|---|---|
| Bill Grabill, Former Refuge Supervisor,<br>Fish and Wildlife Service,<br>Atlanta, Georgia | Refuge Management |
| Dwane Hinson, District Conservationist<br>USDA, Natural Resources Conservation Service<br>Currituck, North Carolina | Soil and Water Conservation<br>Federal Land Conservation Programs |
| John Gagnon, Soil Scientist<br>USDA, Natural Resources Conservation Service<br>Edenton, North Carolina | Soil Science |
| Kevin Moody, Former NEPA Specialist<br>Fish and Wildlife Service,<br>Atlanta, Georgia | National Environmental Policy Act |
| John Ann Shearer, Private Lands Biologist,<br>Fish and Wildlife Service,<br>Raleigh, North Carolina | Wetland Management,<br>Partners for Fish and Wildlife Program |
| Richard Kanaski, Regional Archaeologist,<br>Fish and Wildlife Service,<br>Savannah, Georgia | Cultural Resources |

The planning team formulated the three alternatives based on expert opinion and local concerns. After the team developed the alternatives, the refuge manager and the planning staff met with the North Carolina Wildlife Resources Commission in October 2002. The staff held public meetings on November 18, 19, 20, and 21, 2002 to get public reaction to the alternatives.

**SECTION C. APPENDICES**

# *I. Glossary*

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| *Adaptive Management* | A process in which projects are implemented within a framework of scientifically driven experiments to test predictions and assumptions outlined within the comprehensive conservation plan. The analysis of the outcome of project implementation helps managers determine whether current management should continue as is or whether it should be modified to achieve desired conditions. |
| *Alternative* | Alternatives are different means of accomplishing refuge purposes, goals, and objectives and contributing to the National Wildlife Refuge System. A reasonable way to fix the identified problem or satisfy the stated need. |
| *Approved Acquisition Boundary* | A project boundary that the Director of the Fish and Wildlife Service approves upon completion of the detailed planning and environmental compliance process. This boundary provides a 'working area' for acquisition. The refuge may purchase land from willing sellers within the boundary. It does not mean all lands within the boundary are targeted for acquisition. |
| *Biological Diversity* | The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur. The National Wildlife Refuge System focus is on indigenous species, biotic communities, and ecological processes. |
| *Biological Integrity* | The biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions including the natural biological processes that shape genomes, organisms, and communities. |
| *Canopy* | A layer of foliage; generally the upper-most layer, in a forest stand. It can be used to refer to mid- or under-story vegetation in multi-layered stands. Canopy closure is an estimate of the amount of overhead tree cover (also canopy cover). |
| *Categorical Exclusion* | A category of actions that do not individually or cumulatively have a significant effect on the human environment and have been found to have no such effect in procedures adopted by a federal agency pursuant to the National Environmental Policy Act of 1969. |

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| *CFR* | Code of Federal Regulations. |
| *Compatible Use* | A wildlife-dependent recreational use or any other use of a refuge that, in the sound professional judgment of the refuge manager, will not materially interfere with, or detract from, the fulfillment of the mission or the purposes of the refuge. A compatibility determination supports the selection of compatible uses and identifies stipulations or limits necessary to ensure compatibility. |
| *Comprehensive Conservation Plan* | A document that describes the desired future conditions of the refuge; provides long-range guidance and management direction for the refuge manager to accomplish the purposes, goals, and objectives of the refuge; and contributes to the mission of the National Wildlife Refuge System and meet relevant mandates. |
| *Conservation Easement* | A legal document that provides specific land-use rights to a secondary party. A perpetual conservation easement usually grants conservation and management rights to a party in perpetuity. |
| *Cooperative Agreement* | A simple habitat protection action in which no property rights are acquired. An agreement is usually long-term and can be modified by either party. Lands under a cooperative agreement do not necessarily become part of the National Wildlife Refuge System. |
| *Corridor* | A route that allows movement of individuals from one region or place to another. |
| *Cover Type* | The present vegetation of an area. |
| *Cultural Resources* | The remains of sites, structures, or objects used by people of the past. |
| *Cypress and Tupelo Swamp* | Found in low-lying areas, swales, and open ponds that hold water several months, if not all of the year. Large hollow trees are used as bear den sites. |
| *Deciduous* | Pertaining to perennial plants that are leafless for sometime during the year. |
| *Ecological Succession* | The orderly progression of an area through time in the absence of disturbance from one vegetative community to another. |
| *Ecosystem* | A dynamic and interrelating complex of plant and animal communities and their associated non-living environment. |

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| *Ecosystem Management* | Management of natural resources using system-wide concepts to ensure that all plants and animals in ecosystems are maintained at viable levels in native habitats and basic ecosystem processes are perpetuated indefinitely. |
| *Environmental Health* | It is the composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment. |
| *Even-Aged Forests* | Forests that are composed of trees with a time span of less than 20 years between oldest and youngest individuals. |
| *Endangered Species* | A plant or animal species listed under the Endangered Species Act that is in danger of extinction throughout all or a significant portion of its range. |
| *Endemic Species* | Plants or animals that occur naturally in a certain region and whose distribution is relatively limited to a particular locality. |
| *Environmental Assessment* | A concise document, prepared in compliance with the National Environmental Policy Act, that briefly discusses the purpose and need for an action, alternatives to such action, and provides sufficient evidence and analysis of impacts to determine whether to prepare an environmental impact statement or finding of no significant impact. |
| *Fauna* | All the vertebrate or invertebrate animals of an area. |
| *Federal Trust Species* | All species where the Federal Government has primary jurisdiction including federally threatened or endangered species, migratory birds, anadromous fish, and certain marine mammals. |
| *Fee-title* | The acquisition of most or all of the rights to a tract of land. There is a total transfer of property rights with the formal conveyance of a title. While a fee title acquisition involves most rights to a property, certain rights may be reserved or not purchased, including water rights, mineral rights, or use reservation (the ability to continue using the land for a specified time period, or the reminder of the owner's life). |
| *Finding of No Significant Impact* | A document prepared in compliance with the National Environmental Policy Act, supported by an environmental assessment that briefly presents why a federal action will have no significant effect on the human environment and for which an environmental impact statement, therefore, will not be prepared. |

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| *Floodplain Woods* | Bottomland Hardwood Forests. Consists of hardwoods (old growth and mid-succession age timber) and cypress tupelo stands found on low ridges that drain slowly and subject to flooding. Species include overcup, willow, water oaks, sweetgum, and green ash. Old growth - typically exceeding 120 years of age. Red oaks were removed in the 1940s. Mid-succession - logged timber that may need restoration to improve wildlife habitat. Missing several key oak species. |
| *Fragmentation* | The process of reducing the size and connectivity of habitat patches. The disruption of extensive habitats into isolated and small patches. |
| *Goal* | Descriptive, open-ended, and often broad statements of desired future conditions that convey a purpose but does not define measurable units. |
| *Geographic Information System* | A computer system capable of storing and manipulating spatial data. |
| *Ground Story (flora)* | Vascular plants less than one meter in height, excluding tree seedlings. |
| *Herbaceous Wetland* | Annually or seasonally inundated with vegetation consisting primarily of grasses, sedges, rushes, and cattail. |
| *Historic Conditions* | These are the composition, structure, and functioning of ecosystems resulting from natural processes that we believe, based on sound professional judgment, were present prior to substantial human related changes to the landscape. |
| *Habitat* | The place where an organism lives. The existing environmental conditions required by an organism for survival and reproduction. |
| *Indicator Species* | A species of plant or animals that is assumed to be sensitive to habitat changes and represents the needs of a larger group of species. |
| *In-holding* | Privately owned land inside the boundary of a national wildlife refuge. |
| *Issue* | Any unsettled matter that requires a management decision. |
| *Migratory* | The seasonal movement from one area to another and back. |
| *Monitoring* | The process of collecting information to track changes of selected parameters over time. |

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| *National Environmental Policy* | Requires all agencies, including the Service, to examine the environmental impacts of their actions, incorporate environmental information, and use public participation in the planning and implementation of all actions. Federal agencies must integrate this Act with other planning requirements, and prepare appropriate policy documents to facilitate better environmental decision making. |
| *National Wildlife Refuge* | A designated area of land, water, or an interest in land or water within the National Wildlife Refuge System. |
| *National Wildlife Refuge System* | Various categories of areas administered by the Secretary of the Interior for the conservation of fish and wildlife, including species threatened with extinction, all lands, waters, and interests therein administered by the Secretary as wildlife refuges, wildlife ranges, game ranges, wildlife management areas, or waterfowl production areas. |
| *Native Species* | Species that normally live and thrive in a particular ecosystem. |
| *Neotropical Migratory Bird* | A bird species that breeds north of the United States/Mexican border and winters primarily south of that border. |
| *Objective* | An objective is a concise quantitative (where possible) target statement of what will be achieved. Objectives are derived from goals and provide the basis for determining management strategies. Objectives should be attainable and time-specific. |
| *Planning Area* | A planning area may include lands outside existing planning unit boundaries that are being studied for inclusion in the unit and/or partnership planning efforts. It may also include watersheds or ecosystems that affect the planning area. |
| *Planning Team* | A planning team prepares the comprehensive conservation plan. Planning teams are interdisciplinary in membership and function. A team generally consists of the a planning team leader; refuge manager and staff biologists; staff specialists or other representatives of Service programs, ecosystems or regional offices; and state partnering wildlife agencies as appropriate. |
| *Preferred Alternative* | This is the alternative determined by the decision maker to best achieve the refuge purpose, vision, and goals; contributes to the refuge system mission, addresses the significant issues; and is consistent with principles of sound fish and wildlife management. |
| *Purpose of the Refuge* | The purpose of the refuge is specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge and refuge unit. |

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| *Refuge Operating Needs System* | This is a national database that contains the unfunded operational needs of each refuge. Projects included are those required to implement approved plans and meet goals, objectives, and legal mandates. |
| *Refuge Purposes* | The purposes specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit. |
| *Seral Forest* | A forest in the mature stage of development, usually dominated by large, old trees. |
| *Sink* | A habitat in which local mortality exceeds local reproductive success for a given species. |
| *Sink Population* | A population in a low-quality habitat in which birth rate is generally less than the death rate and population density is maintained by immigrants from source populations. |
| *Source* | A habitat in which local reproductive success exceeds local mortality for a given species. |
| *Source Population* | A population in a high-quality habitat in which birth rate greatly exceeds death rate and the excess individuals leave as migrants. |
| *Step-down Management Plans* | Step-down management plans provide the details necessary to implement management strategies and projects identified in the comprehensive conservation plan. |
| *Strategy* | A specific action, tool, or technique or combination of actions, tools, and techniques used to meet unit objectives. |
| *Threatened Species* | Species listed under the Endangered Species Act that are likely to become endangered within the foreseeable future throughout all or a significant portion of their range. |
| *Trust Species* | Species for which the Fish and Wildlife Service has primary responsibility, including most federally listed threatened and endangered species, anadromous fish once they enter the inland coastal waterways, and migratory birds. |
| *Understory* | Any vegetation with canopy below or closer to the ground than canopies of other plants. |

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| *Wildlife Corridor* | A landscape feature that facilitates the biologically effective transport of animals between larger patches of habitat dedicated to conservation functions. Such corridors may facilitate several kinds of traffic, including frequent foraging movement, seasonal migration, or the once in a lifetime dispersal of juvenile animals. These are transition habitats and need not contain all the habitat elements required by migrants for long-term survival or reproduction. |
| *Wildlife-Dependent Recreation* | A use of a refuge involving hunting, fishing, wildlife observation, wildlife photography and environmental education and interpretation. The National Wildlife Refuge System Improvement Act of 1997 specifies that these are the six priority general public uses of the system. |

# II. References And Literature Cited


Barick, F.B. and T.S. Critcher. 1975. Wildlife and land use planning with particular reference to coastal counties. North Carolina Wildlife Resources Commission. Raleigh, NC. 168 pp.

Bellrose, F.C. 1976. Ducks, geese, and swans of North America. Stackhole Books, Harrisburg, PA. 544 pp.

Carter, M.F., W.C. Hunter, D.N. Pashley, and K.V. Rosenberg. 2000. Setting conservation priorities for landbirds in the United States: The Partners in Flight approach. The Auk 117(2): 541-548.

Dahl, T.E. 2000. Status and trends of wetlands in the conterminous United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C., 82pp.

Cowardin, L. et. al. 1979. Classification of Wetlands and Deepwater Habitats of the United States. United States Fish and Wildlife Service Office of Biological Services FWS/OBS-79/31. 131 pgs.

Eldridge, J. 1992. Management of habitat for breeding and migrating shorebirds in the Midwest.. In Laubhan, M.K., and D. Hamilton. Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Fort Collins, CO

Eubanks, Ted, Paul Kerlinger, and R.H. Payne 1993. High Island, Texas, A Case Study in Avitourism, Birding 25(6):415-420).

Eubanks, Ted, and John Stoll. 1999. Avitourism in Texas: Two Studies of Birders in Texas and Their Potential Support for the Proposed World Birding Center. Texas Parks and Wildlife Contract No. 44467.

Frayer, W.E., T.J. Monahan, D.C. Bowen and F.A. Graybill. 1983. Status and trends of wetlands and deepwater habitats in the conterminous United States: 1950's to 1970's. U.S. Fish and Wildlife Service, Washington, DC. 32pp.

Fredrickson, L.H. and M.E. Heitmeyer. 1988. Waterfowl Use of Forested Wetlands of the Southern United States: An Overview. Pages 307-323 in M.W. Weller, editor. Waterfowl in Winter. University of Minnesota Press, Minneapolis, Minnesota.

Fredrickson, L.H. and F. A. Reid. 1988. Nutritional value of waterfowl foods. In Laubhan, M.K., and D. Hamilton. Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Fort Collins, CO

Fredrickson, L.H. 1991. Strategies for water level manipulation in moist soil systems. In Laubhan, M.K., and D. Hamilton. Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Fort Collins, CO

Frost, C. 1995. Presettlement fire regimes in southeastern marshes, peatlands, and swamps. Pages 39-60 in Susan I. Cerulean and R. Todd Engstrom, eds. Fire in wetlands, a management perspective. Proceedings of the Tall Timbers Fire Ecology Conference, No. 19. Tall Timbers Research Station, Tallahassee, FL.

Frost, C. 1998. Presettlement fire frequency regimes in the United States: a first approximation. Pages 70-81 in Teresa L. Pruden and Leonard A. Brennan, eds. Fire in ecosystem management: shifting the paradigm from suppression to prescription. Proceedings of the Tall Timbers Fire Ecology Conference, No. 20. Tall Timbers Research Station, Tallahassee, FL.

Hamel, P.B. 1992. The Land Manager's Guide to the Birds of the South. The Nature Conservancy and the United States Department of Agriculture Forest Service. Atlanta, Georgia.

Hefner, J.H. and J.D. Brown. 1984. Wetland trends in the southeastern United States. Wetlands 4:1-11.

Hunter, W.C., D.N. Pashley and R.E.F. Escano.1992. Neotropical migratory land bird species and their habitats of special concern within the Southeast region. Pages 159-169 in D.M.

Hunter, W.C., M.F. Carter, D.N. Pashley, and K. Barker. 1993. The Partners in Flight prioritization scheme. Pages 109-119 in Status and management of Neotropical migratory birds (D.M. Finch and P.W. Stangel, Eds.) United States Forest Service General Technical Report RM-229.

Hunter, W.C., L.H. Peoples, and J.A. Collazo. 2001. South Atlantic Coastal Plain Partners in Flight Bird Conservation Plan.

Hunter, W.C. 2004. Southeastern Coastal Plains – Caribbean Regional Shorebird Plan U.S. Shorebird Conservation Plan.

Kerlinger, P. 1994. The economic impact of birding ecotourism on communities surrounding eight National Wildlife Refuges.

Kerlinger, P. 1999. Birding tourism and Dauphin Island.

Korschgen, C.E., and R.B. Dahlgren, 1992. Human disturbances of waterfowl: causes, effects, and management. In Laubhan, M.K., and D. Hamilton. Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Fort Collins, CO

Mathis, M.A. and J.J. Crow. 2000. The Prehistory of North Carolina: An Archaeological Symposium.

Mitsch, W.J. and J.G. Gosselink. 1993. Wetlands. Second Edition. Van Nostrand Reinhold, New York, New York. 722 pp.

National Audubon Society. 1998. Campaign on HR 3267.

New Jersey Department of Environmental Protection, 2000. Wildlife-Associated Recreation on the New Jersey Delaware Bayshore.

North Carolina Economic Security Commission. 2002. Largest Employers by County.

North Carolina Economic Security Commission. 2002. Unemployment Rates by County.

North Carolina Division of Parks and Recreation. 2001. North Carolina Coastal Plain Paddle Trails Guide.

Perry, M.C., P.C. Osenton, G.A. Gough, J.S. Hatfield, and E.J. Lohnes. 1999, Moist-soil management of wetland impoundments for plants and invertebrates. U.S. Geologic Survey Biological Research Division.

Riggs, S.R. and D.K. Belknap. 1988. Upper Cenozoic processes and environments of continental margin sedimentation: eastern United States, p. 131-176 in Sheridan, R.E., and J.A. Graw, eds. The Geology of North America, Vol 1-2, the Atlantic Continental Margin, U.S. Geological Society of America.(RRNWR)

Ringelman, J.K. 1990. Managing agricultural foods for waterfowl. In Laubhan, M.K., and D. Hamilton. Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Fort Collins, CO

Robison, T.M. 1977. Public water supplies of North Carolina, Northern Coastal Plain. U.S. Department of the Interior, pp. 49-50

Schafale, M.P. and Weakely, A.S. 1990. Classification of the Natural Communities of North Carolina. Third Approximation. NC Natural Heritage Program. Raleigh, NC. 325 pp.

U.S. Department of Agriculture. 2002. Census of Agriculture, North Carolina, 2002. Washington, D.C.: U.S. Department of Agriculture.

U.S. Department of Agriculture. 2002. Census of Agriculture, Virginia, 2002. Washington, D.C.: U.S. Department of Agriculture.

U.S. Department of Agriculture, Forest Service. 1991. Forest Statistics for North Carolina Counties - 1991. Resource Bulletin SE-120, Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Agriculture, Forest Service. 1992. Forest Statistics for Virginia Counties - 1991. Resource Bulletin SE-131, Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Agriculture, Soil Conservation Service. 1982. Soil Survey of Currituck County, North Carolina.

U.S. Department of Agriculture, Soil Conservation Service. 1982. Soil Survey of Virginia Beach, Virginia.

U.S. Department of Agriculture. Soil Conservation Service. 1985. Hydric soils of the State of North Carolina 1985. U.S. Department of Agriculture, Soil Conservation Service in cooperation with the National Technical Committee for Hydric Soils. Washington, DC. unpaginated.

U.S. Department of Commerce, Bureau of the Census. 2000. U.S.A. Counties 2000, General Profile, Currituck County, North Carolina. Washington, D.C.:U.S. Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1997. Economic Census, Currituck County, North Carolina. Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Commerce, Bureau of the Census, Small Area Income and Poverty Estimates Program. 2000. Model-Based Income and Poverty Estimates for Currituck County, North Carolina. Washington, D.C.: U.S. Government Printing Office.

U.S. Environmental Protection Agency. 1997. Nature-Based Tourism.

U.S. Fish and Wildlife Service. 1980. Proposed National Wildlife Refuge on the Currituck Outer Banks. Final Environmental Impact Statement. U.S. Fish and Wildlife Service. Northeast Regional Office. Newton Corner, Massachusetts. 364 pp.

U.S. Fish and Wildlife Service. 1981. Significant wildlife resource areas of North Carolina. U.S. Fish and Wildlife Service. Asheville Area Office. Asheville, NC. 139 pp.

U.S. Fish and Wildlife Service. 1994. Preliminary Project Proposal for the Expansion of National Wildlife Refuges in Eastern North Carolina. 124 pp.

U.S. Fish and Wildlife Service. 1998. North American Waterfowl management Plan. 1998 Update – Expanding the Vision.

U.S. Fish and Wildlife Service. 2001. National Survey of Fishing, Hunting and Wildlife Associated Recreation.

U.S. Fish and Wildlife Service. 2001. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation - North Carolina.

Vogelsang, Hans, 2001. Assessing the Economic Impact of Ecotourism Developments on the Albemarle/Pamlico Region.

# III. Relevant Legal Mandates

**National Wildlife Refuge System Authorities**

The mission of the Fish and Wildlife Service is to conserve, protect, and enhance the Nation's fish and wildlife and their habitats for the continuing benefit of the American people. The Service is the primary federal agency responsible for migratory birds, endangered plants and animals, certain marine mammals, and anadromous fish. This responsibility to conserve our Nation's fish and wildlife resources is shared with other federal agencies and state and tribal governments.

As part of this responsibility, the Service manages the National Wildlife Refuge System. This system is the only nationwide system of federal land managed and protected for wildlife and their habitats. The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Mackay Island National Wildlife Refuge is managed as part of this system in accordance with the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, the Refuge Recreation Act of 1962, Executive Order 12996 (Management and General Public Use of the National Wildlife Refuge System), and other relevant legislation, executive orders, regulations, and policies.

**Key Legislation/Policies for Plan Implementation**

The Mackay Island National Wildlife Refuge Draft Comprehensive Conservation Plan describes and illustrates management area projects with standards and guidelines for future decision-making and the staff may adjust them through monitoring and evaluation, as well as amendment and revision. The plan approval establishes conservation and land protection goals, objectives, and specific strategies for the Refuge and its expansion. The refuge manager has identified and approved compatible recreation uses specific to the refuge. This plan provides for systematic stepping down from the overall direction as outlined when making project or activity level decisions. This level involves site-specific analysis (e.g., Forest Habitat Management Plan) to meet National Environmental Policy Act requirements for decision-making.

*Antiquities Act (1906)*
Authorizes the scientific investigation of antiquities on federal land and provides penalties for unauthorized removal of objects taken or collected without a permit.

*Migratory Bird Treaty Act (1918)*
Designates the protection of migratory birds as a federal responsibility. This Act enables the setting of seasons, and other regulations including the closing of areas, federal or non-federal, to the hunting of migratory birds.

*Migratory Bird Conservation Act (1929)*
Establishes procedures for acquisition by purchase, rental, or gift of areas approved by the Migratory Bird Conservation Commission.

*Migratory Bird Hunting and Conservation Stamp Act (1934)*
Authorized the opening of part of a refuge to waterfowl hunting.

*Fish and Wildlife Act (1956*
Established a comprehensive national fish and wildlife policy and broadened the authority for acquisition and development of refuges.

*Fish and Wildlife Coordination Act (1958)*
Allows the Fish and Wildlife Service to enter into agreements with private landowners for wildlife management purposes.

*Refuge Recreation Act (1962)*
Allows the use of refuges for recreation when such uses are compatible with the refuge's primary purposes and when sufficient funds are available to manage the uses.

*Land and Water Conservation Fund Act (1965)*
Uses the receipts from the sale of surplus federal land, outer continental shelf oil and gas sales, and other sources for land acquisition under several authorities.

*National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997, 16 U.S.C. 668dd-668ee. (Refuge Administration Act)*
Defines the National Wildlife Refuge System and authorizes the Secretary of the Interior to permit any use of a refuge provided such use is compatible with the major purposes for which the refuge was established. The Refuge Improvement Act clearly defines a unifying mission for the refuge system; establishes the legitimacy and appropriateness of the six priority public uses (hunting, fishing, wildlife observation, wildlife photography and environmental education and interpretation); establishes a formal process for determining compatibility; established the responsibilities of the Secretary of the Interior for managing and protecting the System; and requires a Comprehensive Conservation Plan for each refuge by the year 2012. This Act amended portions of the Refuge Recreation Act and National Wildlife Refuge System Administration Act of 1966.

*Architectural Barriers Act (1968)*
Requires federally owned, leased, or funded buildings and facilities to be accessible to persons with disabilities.

*National Environmental Policy Act (1969)*
Requires the disclosure of the environmental impacts of any major federal action significantly affecting the quality of the human environment.

*Endangered Species Act (1973)*
Requires all federal agencies to carry out programs for the conservation of threatened and endangered species.

*Rehabilitation Act (1973)*
Requires that programmatic and physical accessibility be made available in any facility funded by the Federal Government, ensuring that anyone can participate in any program.

*Clean Water Act (1977*
Requires consultation with the U.S. Army Corps of Engineers for major wetland modifications.

*Executive Order 11988 (1977)*
Each federal agency shall provide leadership and take action to reduce the risk of flood loss and minimize the impact of floods on human safety, and preserve the natural and beneficial values served by the flood plain.

*Emergency Wetlands Resources Act (1986)*
The purpose of the Act is to promote the conservation of migratory waterfowl and to offset or prevent the serious loss of wetlands by the acquisition of wetlands and other essential habitat, and for other purposes.

*Federal Noxious Weed Act (1990)*
Requires the use of integrated management systems to control or contain undesirable plant species; and an interdisciplinary approach with the cooperation of other federal and state agencies.

*Americans With Disabilities Act (1992)*
Prohibits discrimination in public accommodations and services.

*Executive Order 12996 Management and General Public Use of the National Wildlife Refuge System (1996)*
Defines the mission, purpose, and priority public uses of the National Wildlife Refuge System. It also presents four principles to guide management of the system.

*Executive Order 13007 Indian Sacred Sites (1996)*
Directs federal land management agencies to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners, avoid adversely affecting the physical integrity of such sacred sites, and where appropriate, maintain the confidentiality of sacred sites.

*Emergency Wetland Resources Act of 1986*
This Act authorized the purchase of wetlands from Land and Water Conservation Fund moneys, removing a prior prohibition on such acquisitions. The Act also requires the Secretary of the Interior to establish a National Wetlands Priority Conservation Plan, requires the states to include wetlands in their Comprehensive Outdoor Recreation Plans, and transfers to the Migratory Bird Conservation Fund an amount equal to import duties on arms and ammunition.

*Endangered Species Act of 1973* (16 U.S.C. 1531-1544, 87 Stat. 884), as amended: Public Law 93-205, approved December 28,1973, repealed the Endangered Species Conservation Act of December 5,1969 (P.L. 91-135, 83 Stat. 275). The 1969 act amended the Endangered Species Preservation Act of October 15, 1966 (P.L. 89-669, 80 Stat. 926). The 1973 Endangered Species Act provided for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend, both through federal action and by encouraging the establishment of state programs. The Act authorizes the determination and listing of species as threatened and endangered; prohibits unauthorized taking, possession, sale, and transport of endangered species; provides authority to acquire land for the conservation of listed species, using land and water conservation funds; authorizes establishment of cooperative agreements and grants-in-aid to states that establish and maintain active and adequate programs for threatened and endangered wildlife and plants; authorizes the assessment of civil and criminal penalties for violating the Act or regulations; and authorizes the payment of rewards to anyone furnishing information leading to arrest and conviction of anyone violating the Act and any regulation issued there under.

*Environmental Education Act of 1990(20 USC 5501-5510; 104 Stat. 3325)*
Public Law 101-619, signed November 16,1990, established the Office of Environmental Education within the Environmental Protection Agency to develop and administer a federal environmental education program. Responsibilities of the Office include developing and supporting programs to improve understanding of the natural and developed environment, and the relationships between humans and their environment; supporting the dissemination of educational materials; developing and supporting training programs and environmental education seminars; managing a federal grant program; and administering an environmental internship and fellowship program. The Office is required to develop and support environmental programs in consultation with other federal natural resource management agencies, including the Fish and Wildlife Service.

*Executive Order 11988, Flood Plain Management*
The purpose of this Executive Order, signed May 24, 1977, is to prevent federal agencies from contributing to the adverse impacts associated with occupancy and modification of floodplains and the direct or indirect support of flood plain development. In the course of fulfilling their respective authorities, federal agencies shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by flood plains.

*Fish and Wildlife Improvement Act of 1978*
This act was passed to improve the administration of fish and wildlife programs and amends several earlier laws, including the Refuge Recreation Act, the National Wildlife Refuge System Administration Act, and the Fish and Wildlife Act of 1956. It authorizes the Secretary of the Interior to accept gifts and bequests of real and personal property on behalf of the United States. It also authorizes the use of volunteers on Service projects and appropriations to carry out volunteer programs.

**Historic Preservation Acts**

*Antiquities Act (16 USC 431 - 433)--The Act of June 8, 1906, (34 Stat. 225)*
This act authorizes the President of the United States to designate as National Monuments objects or areas of historic or scientific interests on lands owned or controlled by the United States. The Act required that a permit be obtained for examination of ruins, excavation of archaeological sites and the gathering of objects of antiquity on lands under the jurisdiction of the Secretaries of Interior, Agriculture, and Army, and provided penalties for violations.

*Archaeological Resources Protection Act (16 U.S.C. 470aa - 47011)-- Public Law 96-95, approved October 31, 1979, (93 Stat. 721)*
This act largely supplanted the resource protection provisions of the Antiquities Act for archaeological items. It established detailed requirements for issuance of permits for any excavation for or removal of archaeological resources from Federal and Indian lands. It also established civil and criminal penalties for the unauthorized excavation, removal, or damage of any such resources; for any trafficking in such resources removed from Federal and Indian lands in violation of any provision of federal law; and for interstate and foreign commerce in such resources acquired, transported or received in violation of any state or local law.

*Public Law 100-588, approved November 3, 1988, (102 Stat. 2983:)*
This law lowered the threshold value of artifacts triggering the felony provisions of the Act from $5,000 to $500, made attempting to commit an action prohibited by the Act a violation, and required the land managing agencies to establish public awareness programs regarding the value of archaeological resources to the nation.

*Archaeological and Historic Preservation Act (16 U.S.C. 469-469c)--Public Law 86-523, approved June 27, 1960, (74 Stat. 220), and amended by Public Law 93-291, approved May 24, 1974, (88 Stat. 174)*
This act directed federal agencies to notify the Secretary of the Interior whenever a federal, federally assisted, or licensed or permitted project may cause loss or destruction of significant scientific, prehistoric or archaeological data. The Act authorized use of appropriated, donated and/or transferred funds for the recovery, protection and preservation of such data.

*Historic Sites, Buildings and Antiquities Act (16 U.S.C. 461-462, 464-467)*
The Act of August 21,1935, (49 Stat. 666) popularly known as the Historic Sites Act, as amended by Public Law 89-249, approved October 9,1965, (79 Stat. 971): This act declared it a national policy to preserve historic sites and objects of national significance, including those located on refuges. It provided procedures for designation, acquisition, administration and protection of such sites. Among other things, National Historic and Natural Landmarks are designated under authority of this Act. As of January, 1989, thirty-one national wildlife refuges contained such sites.

*National Historic Preservation Act of 1966 (16 U.S.C. 470-470b, 470c-470n)*
Public Law 89-665, approved October 15,1966, (80 Stat. 915) and repeatedly amended: This act provided for preservation of significant historical features (buildings, objects and sites) through a grant-in-aid program to the states. It established a National Register of Historic Places and a program of matching grants under the existing National Trust for Historic Preservation (16 U.S.C. 468-468d).

The Act established an Advisory Council on Historic Preservation, which was made a permanent independent agency in Public Law 94-422, approved September 28,1976 (90 Stat. 1319). That Act also created the Historic Preservation Fund. Federal agencies are directed to take into account the effects of their actions on items or sites listed in, or eligible for listing in, the National Register of Historic Places. As of January 1989, ninety-one such sites on national wildlife refuges are listed in this Register.

*Land and Water Conservation Fund Act of 1948*
This act provides funding through receipts from the sale of surplus federal land, appropriations from oil and gas receipts from the outer continental shelf, and other sources of land acquisition under several authorities. Appropriations from the fund may be used for matching grants to states for outdoor recreation projects and for land acquisition by various federal agencies, including the Fish and Wildlife Service.

*Migratory Bird Hunting and Conservation Stamp Act (16 U.S.C. 718-718j, 48 Stat. 452), as amended*
The Duck Stamp Act, of March 16, 1934, requires each waterfowl hunter, 16 years of age or older, to possess a valid federal hunting stamp. Receipts from the sale of the stamp are deposited in a special Treasury account known as the Migratory Bird Conservation Fund and are not subject to appropriations.

*National and Community Service Act of 1960 (42 U.S.C. 12401:104 Stat. 3127), Public Law 101-610, signed November 16, 1990*
This act authorizes several programs to engage citizens of the United States in full- and/or part-time projects designed to combat illiteracy and poverty, provide job skills, enhance educational skills, and fulfill environmental needs. Several provisions are of particular interest to the Fish and Wildlife Service.

*American Conservation and Youth Service Corps*
A federal grant program established under Subtitle C of the law, the Corps offers an opportunity for young adults between the ages of 16-25, or in the case of summer programs, 15-21, to engage in approved human and natural resources projects which benefit the public or are carried out on Federal or Indian lands. To be eligible for assistance, natural resource programs must focus on improvement of wildlife habitat and recreational areas, fish culture, fishery assistance, erosion,

wetlands protection, pollution control and similar projects. A stipend of not more than 100 percent of the poverty level will be paid to participants. A Commission established to administer the Youth Service Corps would make grants to States, the Secretaries of Agriculture and Interior and the Director of ACTION to carry out these responsibilities.

*National Environmental Policy Act of 1959 (P.L. 91-190,42 U.S.C. 4321-4347, January 1, 1970, 83 Stat. 852) as amended by Public Law 94-52, July 3, 1975, 89 Stat. 258, and Public Law 94-83, August 9,1975, 89 Stat. 424)*

Title I of the 1969 National Environmental Policy Act requires that all federal agencies prepare detailed environmental impact statements for every recommendation or report on proposals for legislation and other major federal actions significantly affecting the quality of the human environment. The 1969 statute stipulated the factors to be considered in environmental impact statements, and required that federal agencies employ an interdisciplinary approach in related decision-making and develop means to ensure that unquantified environmental values are given appropriate consideration, along with economic and technical considerations. Title II of this statute requires annual reports on environmental quality from the President to the Congress, and established a Council on Environmental Quality in the Executive Office of the President with specific duties and functions.

*National Wildlife Refuge System Improvement Act of 1997*
Public Law 105-57, amended the National Wildlife Refuge System Act of 1966 (16 U.S.C. 668dd-ee), and provided guidance for management and public use of the refuge system. The Act mandates that the refuge system be consistently directed and managed as a national system of lands and waters devoted to wildlife conservation and management. The Act establishes priorities for recreational uses of the refuge system. Six wildlife-dependent uses are specifically named in the Act: hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation. These activities are to be promoted on the refuge system, while all non-wildlife-dependent uses are subject to compatibility determinations. A compatible use is one that, in the sound professional judgment of the refuge manger, will not materially interfere with, or detract from, fulfillment of the National Wildlife Refuge System Mission or refuge purpose(s). As stated in the Act, The mission of the system is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. The Act also requires development of a comprehensive conservation plan for each refuge and that management be consistent with the plan. When writing a plan for expanded or new refuges, and when making management decisions, the Act requires effective coordination with other federal agencies, state fish and wildlife or conservation agencies, and refuge neighbors. A refuge must also provide opportunities for public involvement when making a compatibility determination.

*North American Wetlands Conservation Act (103 Stat. 1968; 16 U.S.C. 44O1~4412) Public Law 101-233, enacted December 13, 1989*

This act provides funding and administrative direction for implementation of the North American Waterfowl Management Plan and the Tripartite Agreement on Wetlands between Canada, the United States and Mexico. The Act converts the Pittman-Robertson account into a trust fund, with the interest available without appropriation through the year 2006, to carry out the programs authorized by the Act, along with an authorization for annual appropriation of $15 million plus an amount equal to the fines and forfeitures collected under the Migratory Bird Treaty Act. Available funds may be expended, upon approval of the Migratory Bird Conservation Commission, for payment of not to exceed 50 percent of the United States' share of the cost of wetlands conservation projects in Canada, Mexico, or the United States (or 100

percent of the cost of projects on federal lands). At least 50 percent and no more than 70 percent of the funds received are to go to Canada and Mexico each year.

*Refuge Recreation Act of 1952*
This Act authorizes the Secretary of the Interior to administer refuges, hatcheries, and other conservation areas for recreational use, when such uses do not interfere with the area's primary purposes. It authorizes construction and maintenance of recreational facilities and the acquisition of land for incidental fish and wildlife oriented recreational development or protection of natural resources. It also authorizes the charging of fees for public uses.

*Refuge Revenue Sharing Act (16 U.S.C. 715s)*
Section 401 of the Act of June 15,1935, (49 Stat. 383) provided for payments to counties in lieu of taxes, using revenues derived from the sale of products from refuges. Public Law 88-523, approved August 30,1964, (78 Stat. 701) made major revisions by requiring that all revenues received from refuge products, such as animals, timber and minerals, or from leases or other privileges, be deposited in a special Treasury account and net receipts distributed to counties for public schools and roads. Public Law 93-509, approved December 3,1974, (88 Stat. 1603) required that moneys remaining in the fund after payments be transferred to the Migratory Bird Conservation Fund for land acquisition under provisions of the Migratory Bird Conservation Act. Public Law 95-469, approved October 17, 1978, (92 Stat. 1319) expanded the revenue sharing system to include National Fish Hatcheries and Service research stations. It also included in the Refuge Revenue Sharing Fund receipts from the sale of salmonid carcasses. Payments to counties were established as follows: on acquired land, the greatest amount calculated on the basis of 75 cents per acre, three-fourths of one percent of the appraised value, or 25 percent of the net receipts produced from the land; and on land withdrawn from the public domain, 25 percent of net receipts and basic payments under Public Law 94-565 (31 U.S.C. 1601-1607, 90 Stat. 2662). This amendment also authorized appropriations to make up any difference between the amount in the fund and the amount scheduled for payment in any year. The stipulation that payments be used for schools and roads was removed, but counties were required to pass payments along to other units of local government within the county that suffer losses in revenues due to the establishment of Service areas.

*Wilderness Act of 1954: Public Law 88-577*
Approved September 3, 1964, directed the Secretary of the Interior, within 10 years, to review every roadless area of 5,000 or more acres and every roadless island (regardless of size) within National Wildlife Refuge and National Park Systems for inclusion in the National Wilderness Preservation System.

# IV. Public Participation

The Service invited these agencies, organizations, businesses, and citizens to participate in four public scoping meetings on June 19, 21, 26, and 28, 2001 in Currituck, North Carolina, Corolla, North Carolina, Virginia Beach, Virginia, and Knotts Island, North Carolina. The staff introduced the audience of sixty-one citizens to the refuge and its planning process and asked them to identify their issues and concerns. The Service published announcements giving the location, date, and time for the public meeting in the Federal Register and legal notices in local newspapers. The staff also sent press releases to local newspapers and public service announcements to television and radio stations. Service personnel placed fifty posters announcing the meeting in local post offices, local government buildings, and stores.

The planning teams expanded the issues and concerns to include those generated by the agencies, organizations, businesses, and citizens from the local community. These issues and concerns formed the basis for the development and comparison of the objectives in the different alternatives described in this environmental assessment.

The objectives were subjects of discussion at a second round of public meetings on November 18, 19, 20, and 21, 2002 in Corolla, Currituck, and Knotts Island, North Carolina, and Virginia Beach, Virginia. The staff published announcements giving the location, date, and time for the public meeting as legal notices in local newspapers. The staff also sent press releases to local newspapers and public service announcements to television and radio stations. Service personnel placed seventy-five posters announcing the meeting in local post offices, local government buildings, and stores. Thirty citizens attended the four meetings.

The issues raised at the meetings are on the next pages, followed by worksheets the workshop participants completed at each workshop.

**Mackay and Currituck National Wildlife Refuges**
**Comprehensive Conservation Plan Scoping Meetings**
June 19, 21, 26, 28, 2001

*Mackay Island National Wildlife Refuge Issues*

| Area of Concern | Issue | Disposition |
|---|---|---|
| **Wildlife-General** | Continue surveys | In plan |
| | Secure funding | In plan |
| | Hire adequate staff | In plan |
| | Coordinate with other agencies | In plan |
| | Use hunters to collect data | Inventory step-own plan |
| | Use hunters to control nutria | Pest control step-down plan |
| | Manage raccoons and fox | Inventory step-down plan |
| | Introduce sika deer | Against Service policy |
| **Habitat-Overall** | Cooperate with NCWRC | In plan |
| | Hire more staff | In plan |
| | Maintain flexibility in management | In plan |
| | Maintain prescribed fire program | In plan |
| | Increase prescribed fire program | In plan |
| | Improve deer habitat | In plan |
| | Improve shorebird habitat | In plan |
| | Provide wild turkey habitat | Not practical |
| | Provide black bear habitat | Not practical |
| **Habitat-Marsh** | Install water control structure at Corey's Ditch | In plan |
| **Habitat-Cropland** | Grow crops for wildlife | In plan |
| **Habitat-SAV** | Restore SAV | Beyond refuge boundaries |
| **Public Use-Overall** | Hire public use staff | In plan |
| | Continue public use | In plan |
| **Public Use-Access** | Increase the number of open road days | In plan |
| | Decrease parking lot size | Inadequate parking now |
| | Allow horseback riding | Inadequate facilities and parking |

*Mackay Island National Wildlife Refuge Issues*

| Area of Concern | Issue | Disposition |
|---|---|---|
| **Public Use-Hunting** | Cooperate with NCWRC | In plan |
| | Continue hunting | In plan |
| | Provide access to handicapped | In plan; Details in hunting step-down plan |
| | Hunt deer from assigned stands | Inadequate staff to maintain and monitor |
| | Expand hunting to new acquisitions | Hunting step-down plan |
| | Expand hunting season during rut season | Hunting step-down plan |
| | Expand hunting season in December | Hunting step-down plan |
| | Allow dove and quail hunting | Hunting step-down plan |
| | Allow hunting on Sunday | Subject to state law |
| | Increase the number of hunting days | Hunting step-down plan |
| | Allow resident Canada goose hunting | Hunting step-down plan |
| | Sponsor youth deer hunts | Hunting step-down plan |
| | Provide access for handicapped hunters | Hunting step-down plan |
| | Allow drives for deer with hunters | Hunting step-down plan |
| | Sponsor hunter safety course | NCWRC program |
| **Public Use-Fishing** | Increase access for fishing by the disabled | Plan only maintains existing pier |
| | Add boat ramps | Plan only maintains existing ramp |
| | Host youth fishing day | In plan |
| | Provide bulk-headed area around fishing pier for disabled | In plan |
| | Support extension of striped bass season | Beyond refuge jurisdiction |
| **Mackay Island National Wildlife Refuge Issues** | | |
| **Area of Concern** | Issue | Disposition |
| **Public Use – Wildlife Observation** | Increase vehicle access | In plan |

| Area of Concern | Issue | Disposition |
|---|---|---|
| | Provide pedestrian access | In plan |
| | Provide vantage points | In plan |
| | Provide tower | In plan |
| | Provide access beyond office hours | In plan |
| | Increase access to disabled | Existing access maintained |
| | Allow kayak tours | In Alternative 3 |
| | Provide tours in vans | Number of organized tours increased |
| | Provide view of eagle nest on remote video screen | In Alternative 3 |
| **Public Use Environmental Education** | Use refuge for education | In plan |
| | Cooperate with agencies | In plan |
| | Increase education | In plan |
| | Educate youth | In plan |
| **Public Use Interpretation** | Interpret contributions of Joseph P. Knapp | In plan |
| **Public Use-Outreach** | Advertise refuge programs more | In plan |
| | Develop and maintain newsletter | In plan |
| **Public Use-Volunteer Program** | Start volunteer program | Already in place |
| | Target volunteers for certain activities | Will be coordinated by designated staff member |
| **Resource Protection Cultural Resources** | Cooperate with other agencies/organizations | In plan |
| | Acknowledge heritage of duck clubs | In plan |
| | Pick up artifacts in cropland as a special event and put in a museum | Inventory step-down plan |

*Mackay Island National Wildlife Refuge Issues*

| Area of Concern | Issue | Disposition |
|---|---|---|
| **Resource Protection Land Protection** | Acquire land | Land Protection Plan |
| | Acquire land for upland mammals | Land Protection Plan |
| | Do not acquire land | Land Protection Plan |
| | Hire staff to handle land acquisition | Land Protection Plan |
| | Use cooperative agreements | Land Protection Plan |
| **Resource Protection Law Enforcement** | Hire more staff | In plan |
| | Provide better guidance on regulations | In plan |
| | Cooperate better with NCWRC | In plan |
| | Watch Corey's Ditch for fishing violations | In plan |
| | Restrict speedboats in the sound | Beyond refuge authority |
| | Establish rest areas for waterfowl | Beyond refuge authority |
| | Expand proclamation boundary for SAV | Beyond refuge authority |
| **Resource Protection-Pest Plants** | Continue Phragmites control | In plan |
| | Control alligatorweed | Pest Plant Control Plan |
| | Track invasive species | Pest Plant Control Plan |
| **Resource Protection Water Quality** | Maintain water quality for fish | In plan |
| | Increase water quality monitoring | In plan |
| | Monitor water quality in sound waters | Beyond refuge authority |

**MACKAY ISLAND NATIONAL WILDLIFE REFUGE PLANNING ISSUES WORKSHEET**
**(5 respondents)**

| ACTIVITY | WHAT WOULD YOU LIKE US TO DO ? | |
|---|---|---|
| (Options to eliminate the activity or decrease it were presented, but were not selected by anyone.) | | |
| WILDLIFE SURVEYS AND MANAGEMENT | Keep the Same | Increase |
| Waterfowl Survey and Management | 100% | 0% |
| Shorebird Survey and Management | 60% | 40% |
| Land Bird Survey and Management | 60% | 40% |
| Reptile/Amphibian Survey and Management | 40% | 60% |
| Fish Survey and Management | 40% | 60% |
| Endangered Species Survey and Management | 40% | 60% |
| White-tailed Deer Management | 60% | 40% |
| **HABITAT MANAGEMENT ACTIVITIES** | | |
| Vegetation Survey | 60% | 40% |
| Water Quality Monitoring | 40% | 60% |
| Water Management (Farming, Moist Soil) | 60% | 40% |
| Prescribed Burning | 60% | 40% |
| Forest Thinning | 80% | 20% |
| Mechanical Vegetation Management | 80% | 20% |
| Chemical Vegetation Management | 80% | 20% |
| Shoreline Maintenance | 80% | 20% |
| Planting, Seeding, Clearing for Habitat Improvement | 80% | 20% |
| Habitat Restoration (Hydrology, Reforestation) | 80% | 20% |
| Wildlife Management | 80% | 20% |
| Plant Pest Insect and Disease Management | 80% | 20% |
| Exotic and Invasive Species Eradication | 40% | 60% |
| Special Protection Status (National Wilderness) | 60% | 40% |
| PUBLIC USE ACTIVITIES AND FACILITIES | Keep the Same | Increase |
| Fishing | 20% | 80% |
| Hunting | 20% | 80% |
| Environmental Education (School Students) | 80% | 20% |

| ACTIVITY | WHAT WOULD YOU LIKE US TO DO ? | |
|---|---|---|
| Environmental Education (School Teachers) | 60% | 40% |
| Wildlife Interpretation (Formal Programs) | 60% | 40% |
| Wildlife Interpretation (Printed Material) | 50% | 40% |
| Wildlife Interpretation (Walking Trails) | 60% | 40% |
| Wildlife Interpretation (Canoeing Trails) | 60% | 40% |
| Wildlife Interpretation (Buildings, Kiosks) | 80% | 20% |
| Wildlife Interpretation (Interpretative Signs) | 60% | 40% |
| Wildlife Photography Opportunities | 40% | 60% |
| Wildlife Observation Opportunities | 40% | 60% |
| Vehicle Parking Lots | 40% | 60% |
| Access for Fishing, Boating, Canoeing | 60% | 40% |
| **RESOURCE PROTECTION ACTIVITIES** | | |
| Visitor Protection | 80% | 20% |
| Wildlife Protection | 40% | 60% |
| Proclamation Boundary Enforcement | 40% | 60% |
| Trespass Violations | 40% | 60% |
| Littering/Dumping Violations | 40% | 60% |
| Hunting and Fishing Compliance Checks | 40% | 60% |
| Other Regulations | 60% | 40% |
| Special Protection Status (National Wilderness) | 80% | 20% |
| Land Acquisition | 60% | 40% |
| **OPERATION AND MAINTENANCE** | | |
| Canal Maintenance | 60% | 40% |
| Road and Firebreak Maintenance | 60% | 40% |
| Facilities Maintenance (Signs, Buildings) | 60% | 40% |
| Dike and Trail Maintenance | 60% | 40% |
| Water Control Structures, Pump Stations | 60% | 40% |
| Boundary Posting | 80% | 20% |

**MACKAY ISLAND NATIONAL WILDLIFE REFUGE**
**PLANNING ALTERNATIVES WORKSHEET (7 respondents)**

| ACTIVITY | WHICH ALTERNATIVE WOULD YOU LIKE US TO DO? (CAN MIX AND MATCH DIFFERENT ALTERNATIVES FOR DIFFERENT ACTIVITIES) | | |
|---|---|---|---|
| | Alternative 1 | Alternative 2 | Alternative 3 |
| **WILDLIFE MANAGEMENT ACTIVITIES** | | | |
| **Fish** | 0% | 14% | 86% |
| **Invertebrates** | 0% | 43% | 57% |
| **Mammals** | 0% | 14% | 86% |
| **Land Birds** | 14% | 0% | 86% |
| **Reptiles and Amphibians** | 14% | 29% | 57% |
| **Shorebirds (Terns, Gulls)** | 29% | 29% | 42% |
| **Wading Birds (Herons, Egrets)** | 0% | 29% | 71% |
| **Waterfowl (Ducks, Geese)** | 0% | 43% | 57% |
| **HABITAT MANAGEMENT ACTIVITIES** | | | |
| **All Habitats** | 0% | 14% | 86% |
| **Coastal Fringe Evergreen Forest (Pines)** | 14% | 14% | 72% |
| **Mesic Mixed Hardwood Forest (Uplands)** | 0% | 0% | 100% |
| **Cypress Gum Swamp** | 0% | 14% | 86% |
| **Open Water** | 14% | 0% | 86% |
| **Brackish Marsh (Grass Dominated Wetlands)** | 0% | 29% | 71% |
| **Roads** | 57% | 14% | 29% |
| **Firebreaks** | 42% | 29% | 29% |
| **Cropland** | 0% | 71% | 29% |
| **Wood Duck Boxes** | 0% | 43% | 57% |
| **Moist Soil Units (Managed Wetlands)** | 0% | 43% | 57% |
| **PUBLIC USE ACTIVITIES** | | | |
| **Hunting** | 29% | 42% | 29% |
| **Fishing** | 14% | 57% | 29% |
| **Environmental Education (Staffed Programs)** | 14% | 72% | 14% |
| **Environmental Interpretation** | 0% | 57% | 43% |
| **Wildlife Observation** | 0% | 29% | 71% |
| **Wildlife Photography** | 0% | 29% | 71% |
| **Access (to the refuge via roads)** | 14% | 43% | 43% |

| ACTIVITY | WHICH ALTERNATIVE WOULD YOU LIKE US TO DO? (CAN MIX AND MATCH DIFFERENT ALTERNATIVES FOR DIFFERENT ACTIVITIES) | | |
|---|---|---|---|
| | Alternative 1 | Alternative 2 | Alternative 3 |
| **PUBLIC USE ACTIVITIES** | | | |
| **Outreach (Publicity and Public Relations)** | 29% | 42% | 29% |
| **Refuge Support (Friends Group)** | 0% | 57% | 43% |
| **Special Events (Festivals, Field Days)** | 14% | 72% | 14% |
| **RESOURCE PROTECTION ACTIVITIES** | | | |
| **Cultural Resources** | 14% | 43% | 43% |
| **Interagency Coordination** | 0% | 71% | 29% |
| **Law Enforcement** | 0% | 71% | 29% |
| **Permits** | 14% | 72% | 14% |
| **Law Enforcement** | 0% | 71% | 29% |
| **Pest Animals** | 14% | 43% | 43% |
| **Pest Plants** | 14% | 43% | 43% |
| **Significant Natural Heritage Areas** | 72% | 14% | 14% |
| **Water Quality** | 0% | 29% | 71% |
| **Wilderness Areas** | 29% | 29% | 42% |
| **Wildlife Disease** | 29% | 29% | 42% |

# *V. Decisions and Approvals*

*INTRA-SERVICE SECTION 7 BIOLOGICAL EVALUATION*

**Originating Person**: Tim Cooper
**Telephone Number**: 252-429-3100
**E-Mail:** tim_cooper@fws.gov
**Date:**

**Project Name**: Mackay Island National Wildlife Refuge Comprehensive Conservation Plan

**I. Service Program:**
___ Ecological Services
___ Federal Aid
___ Clean Vessel Act
___ Coastal Wetlands
___ Endangered Species Section 6
___ Partners for Fish and Wildlife
___ Sport Fish Restoration
___ Wildlife Restoration
___ Fisheries
_X_ Refuges/Wildlife

**II. State/Agency**: North Carolina/ U.S. Fish and Wildlife Service

**III. Station Name:** Mackay Island National Wildlife Refuge

**IV. Description of Proposed Action (attach additional pages as needed):** Implementation of the Comprehensive Conservation Plan for Mackay Island National Wildlife Refuge by adopting the preferred alternative that provides guidance, management direction, and operation plans for the next 15 years.

**V. Pertinent Species and Habitat:**

**A. Include species/habitat occurrence map:**

Bald eagles have nested on the refuge since 1998.

**B. Complete the following table.**

| SPECIES/CRITICAL HABITAT | STATUS |
|---|---|
| Bald Eagle | Threatened |
| Red-cockaded Woodpecker | Endangered |
| West Indian Manatee | Endangered |

**VI. Location (attach map):**

**A. Ecoregion Number and Name**: Roanoke-Tar-Neuse-Cape Fear No. 34

**B. County and State:** Currituck, North Carolina, and Virginia Beach, Virginia

**C. Section, township, and range (or latitude and longitude**):

**D. Distance (miles) and direction to nearest town**: Adjacent to and immediately south of Virginia Beach, Virginia

**E. Species/habitat occurrence:**

Bald Eagle - occasionally observed during winter. One active nest.

Red-cockaded Woodpecker - Record of occurrence more than 20 years old.

West Indian Manatee - Incidental record of occurrence outside of its normal range.

**VII. Determination of Effects:**

**A. Explanation of effects of the action on species and critical habitats in item V. B (attach additional pages as needed).**

| SPECIES/CRITICAL HABITAT | IMPACTS TO SPECIES/CRITICAL HABITAT |
|---|---|
| Bald Eagle | Disturbance by staff and visitors during nesting season. |
| Red-cockaded Woodpecker | Disturbance by staff and visitors during nesting season. Lack of understory management. |
| West Indian Manatee | Disturbance by boaters and anglers. Water quality degradation and lack of submerged aquatic vegetation. |

**B. Explanation of actions to be implemented to reduce adverse effects.**

| SPECIES/CRITICAL HABITAT | ACTIONS TO MITIGATE/MINIMIZE IMPACTS |
|---|---|
| Bald Eagle | Restrict access to nesting area. |
| Red-cockaded Woodpecker | Restrict access to nesting area. Allow pines to grow old enough to develop cavities. Manage understory to maintain height below cavities. |
| West Indian Manatee | Restrict access when manatees are in the area. Cooperate with state agencies to monitor and improve water quality. |

**VIII. Effect Determination and Response Requested:**

| SPECIES/CRITICAL HABITAT | DETERMINATION | | | RESPONSE REQUESTED[1] |
|---|---|---|---|---|
| | NE | NA | AA | |
| Bald Eagle | | X | | |
| Red-cockaded Woodpecker | | X | | |
| West Indian Manatee | | X | | |

[1]DETERMINATION/RESPONSE REQUESTED:
NE = no effect. This determination is appropriate when the proposed action will not directly, indirectly, or cumulatively impact, either positively or negatively, any listed, proposed, candidate species or designated/proposed critical habitat. Response Requested is optional but a Concurrence is recommended for a complete Administrative Record.

NA = not likely to adversely affect. This determination is appropriate when the proposed action is not likely to adversely impact any listed, proposed, candidate species or designated/proposed critical habitat or there may be beneficial effects to these resources. Response Requested is a Concurrence.

AA = likely to adversely affect. This determination is appropriate when the proposed action is likely to adversely impact any listed, proposed, candidate species or designated/proposed critical habitat. Response Requested for listed species is Formal Consultation. Response Requested for proposed or candidate species is Conference.

_____ _____
Signature (originating station) Date

_____
Title

**IX. Reviewing Ecological Services Office Evaluation:**

**A. Concurrence _____ Nonconcurrence _____**

**B. Formal consultation required _____**

**C. Conference required _____**

**D. Informal conference required _____**

**E. Remarks (attach additional pages as needed):**

_____ _____
Signature Date

_____ _____
Title Office

**Mackay Island National Wildlife Refuge**

Uses: The following uses were considered for compatibility determination reviews: hunting, fishing, wildlife observation, wildlife photography, environmental education, interpretation, trapping of selected furbearers for nuisance animal management, forest management program, and refuge resource research studies. A description and anticipated biological impacts for each use are addressed separately in this compatibility determination.

Refuge Name: Mackay Island National Wildlife Refuge.

**Date Established:** 1960

**Establishing and Acquisition Authority:** 16 U.S.C. Sec. 664 (Migratory Bird Conservation Act of 1929).

Refuge Purpose: The purpose of Mackay Island National Wildlife Refuge, as reflected in the refuge's authorizing legislation, is to protect and conserve migratory birds, and other wildlife resources through the protection of wetlands, in accordance with the following laws:

...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds... 16 U.S.C. Sec. 664 (Migratory Bird Conservation Act of 1929);

...for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species and threatened species... 16 U.S.C. Sec 460k-1 (Refuge Recreation Act of 1962)

The refuge's purpose and importance to migratory birds, particularly waterfowl, are to preserve wintering habitat for waterfowl and wintering and production habitat for wood ducks to meet the habitat goals presented in the Ten-Year Waterfowl Habitat Acquisition Plan and the North American Waterfowl Management Plan.

On August 15, 1967, the Secretary of the Interior signed a proclamation prohibiting waterfowl hunting on the refuge and the waters to the south of the refuge.

**National Wildlife Refuge System Mission:** The mission of the Refuge System, as defined by the National Wildlife Refuge System Improvement Act of 1997, is:

... to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

**Other Applicable Laws, Regulations, and Policies:**

Antiquities Act of 1906 (34 Stat. 225)
Migratory Bird Treaty Act of 1918 (15 U.S.C. 703-711; 40 Stat. 755)
Migratory Bird Conservation Act of 1929 (16 U.S.C. 715r; 45 Stat. 1222)
Migratory Bird Hunting Stamp Act of 1934 (16 U.S.C. 718-178h; 48 Stat. 451)
Criminal Code Provisions of 1940 (18 U.S.C. 41)
Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d; 54 Stat. 250)
Refuge Trespass Act of June 25, 1948 (18 U.S.C. 41; 62 Stat. 686)

Fish and Wildlife Act of 1956 (16 U.S.C. 742a-742j; 70 Stat.1119)
Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4; 76 Stat. 653)
Wilderness Act (16 U.S.C. 1131; 78 Stat. 890)
Land and Water Conservation Fund Act of 1965
National Historic Preservation Act of 1966, as amended (16 U.S.C. 470, et seq.; 80 Stat. 915)
National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd, 668ee; 80 Stat. 927)
National Environmental Policy Act of 1969, NEPA (42 U.S.C. 4321, et seq; 83 Stat. 852)
Use of Off-Road Vehicles on Public Lands (Executive Order 11644, as amended by Executive Order 10989)
Endangered Species Act of 1973 (16 U.S.C. 1531 et seq; 87 Stat. 884)
Refuge Revenue Sharing Act of 1935, as amended in 1978 (16 U.S.C. 715s; 92 Stat. 1319)
National Wildlife Refuge Regulations for the Most Recent Fiscal Year (50 CFR Subchapter C; 43 CFR 3101.3-3)
Emergency Wetlands Resources Act of 1986 (S.B. 740)
North American Wetlands Conservation Act of 1990
Food Security Act (Farm Bill) of 1990 as amended (HR 2100)
The Property Clause of the U.S. Constitution Article IV 3, Clause 2
The Commerce Clause of the U.S. Constitution Article 1, Section 8
The National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57, USC668dd)
Executive Order 12996, Management and General Public Use of the National Wildlife Refuge System, March 25, 1996
Title 50, Code of Federal Regulations, Parts 25-33
Archaeological Resources Protection Act of 1979
Native American Graves Protection and Repatriation Act of 1990

Compatibility determinations for each description listed were considered separately. Although for brevity, the preceding sections from Uses through Other Applicable Laws, Regulations and Policies are only written once within the plan, they are part of each descriptive use and become part of that compatibility determination if considered outside of the comprehensive conservation plan.

**Description of Use:**

*Hunting*

The refuge is a mixture of marshes, managed wetlands (moist-soil areas), and forest blocks of loblolly pine and bottomland hardwoods, and interconnected streams, ditches, and backswamps. The forests have a great variety of tree species that includes baldcypress, tupelo gum, oak, red maple, black gum, hickory, elm, green ash, and willow. This rich forested wetland provides good habitat for a number of game species including white-tailed deer, squirrel, raccoon, woodcock and waterfowl.

Many of the local residents enjoy an informal, rural lifestyle that includes frequent recreational use of the area's natural resources. Hunting and fishing have been, and continue to be, popular uses of refuge lands. The refuge has permitted hunting since 1983, when the Service first approved hunting of deer on the refuge. The administration, as well as special regulations for hunting, has changed over time but the majority of the program has remained unchanged.

On August 21, 1963, the Secretary of the Interior signed a proclamation prohibiting waterfowl hunting on the refuge and the waters to the south of the refuge.

The comprehensive conservation plan calls for the continued hunting of deer. All hunts fall within the framework of the State's open seasons and follow state regulations. There are additional refuge-specific regulations to supplement State regulations. These refuge-specific regulations are reviewed

annually and incorporated into the hunting brochure. The draft comprehensive conservation plan would increase law enforcement presence during hunting seasons; would evaluate the hunt program annually; and modify seasons, hunt areas or regulations if necessary. The refuge could add hunting areas as it expands through an active land acquisition program. Implementation of the proposed alternative, as described in the draft comprehensive conservation plan, would ensure that opportunities for various types of wildlife-dependent recreation would continue for future generations.

Availability of Resources: Based on a review of the refuge's budget allocated for this activity, there is adequate funding to ensure compatibility and to administer this use at its current level. Additional fiscal resources are needed to conduct this use as proposed. A permanent, full-time law enforcement officer and public use specialist are needed to assist with hunting program administration and visitor service.

Anticipated Impacts of the Use: The deer herd has expanded and increased substantially since the refuge was established. Prior to refuge establishment, this portion of Currituck County was subject to excessive deer poaching that maintained the deer herd at low levels. Following refuge establishment and initiation of an effective wildlife law enforcement program, the deer herd has increased substantially in and around the refuge. The refuge's marsh and forest habitat, combined with commercially harvested forests and agricultural fields adjacent to the refuge, provides ideal habitat conditions for white-tailed deer.

Harvest management of big game (white-tailed deer) is the art of combining wildlife science and landowner objectives for the attainment of a specific management goal. Refuge hunt plan objectives should determine harvest management strategies. A complete analysis of biological data should determine the objectives. Specific harvest objectives allow the setting of hunting regulations. The refuge staff will thoroughly evaluate the results of each hunting season to ensure that the harvest management program remains dynamic and responsive to an evolving management environment (Bookhout 1994).

The refuge's great variety and abundance of high-quality wetland areas provide outstanding habitat for a variety of waterfowl and wading birds. Primary species include American black duck, gadwall, mallard, green-wing teal, snowy egret, and great egret. The area's habitat for neotropical migratory birds is also outstanding. Neotropical migratory birds use the marsh and forested areas and edges. Disturbance to all migratory birds would be minimal and temporary, as the staff would alter habitat slightly for the betterment of these species.

Based on available information, biologists have not documented any threatened or endangered species, other than the bald eagle, on Mackay Island National Wildlife Refuge. It is anticipated that the current levels and expected future levels of hunting or other wildlife-dependent recreation activities would not directly, indirectly, or cumulatively impact any listed, proposed, or candidate species or designated/proposed critical habitat. Data gathered from future biological surveys regarding the importance or potential importance of the refuge to threatened or endangered species or critical habitat, or proposed threatened, endangered, or critical habitat, could result in changes to public use activities across time; however, these changes would have no effect on listed species.

The incidental take of other wildlife species, either illegally or unintentionally, may occur with any consumptive use program. At current and anticipated public use levels, incidental take would be very small and would not directly or cumulatively impact current or future populations of wildlife either on this refuge or in the surrounding areas. Implementation of an effective law enforcement program and development of site-specific refuge regulations and special conditions would eliminate most incidental take problems.

**Determination (check one below):**

_____ Use is Not Compatible

__X__ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility: The refuge permits hunting in accordance with the State's regulations and licensing requirements. An environmental assessment is on file at the refuge headquarters as part of the Hunting Plan. Following completion of the comprehensive conservation plan, the staff will revise the Hunting Plan. The following stipulations will help ensure the refuge hunting program is compatible with refuge purposes.

- Vehicles are restricted to designated refuge roads and parking lots.
- Firearms, bows, and other weapons are prohibited except during designated hunting seasons.
- Hunting deer with dogs is not allowed on the refuge.
- All hunts are designed to provide quality user opportunities based upon sustainable known wildlife population levels and biological parameters. Hunt season dates and bag limits will be adjusted, as needed, to achieve balanced wildlife population levels within carrying capacities, regardless of impacts to user opportunities.

As the staff collects additional data and develops a long-range hunt plan, it could implement additional refuge-specific regulations. These regulations could include, but may not be limited to, season dates that are more restrictive from those in surrounding State zones, refuge permit requirements, and closed areas. **The objectives of the regulations may be to reduce disturbance to specific wildlife species or habitats, such as bird rookeries, wintering waterfowl, or threatened and endangered species to allow hunting when staff is available to administer it, or to provide for public safety (Korschgen and Dahlgren 1992).**

Justification: Hunting is compatible with the purposes for which the refuge was established and the mission of the National Wildlife Refuge System. It is one of the public use recreational activities that the 1997 National Wildlife Refuge System Improvement Act specifically identifies as a use to be allowed where possible on refuges. The refuge uses deer hunts as management tools to protect the diverse ecosystem.

**Mandatory 10- or 15-year Re-evaluation Date: _____**

**Description of Use:**

*Fishing*

Sport fishing is a common public use on the State waters of the creeks, rivers, bays, and sounds from the shorelines located on the Mackay Island National Wildlife Refuge and the banks of ditches and impoundments on the refuge. Fish creel limits, boating safety, and license requirements are in accordance with State of North Carolina and Commonwealth of Virginia regulations. A fishing pier accessible to disabled visitors is maintained in the northeastern corner of the East Pool. A public boat ramp for small boats is located at the dike gate on Mackay Island Road. Development of more public access to the water on the refuge would allow the public to utilize these important fishery resources. As identified in the draft comprehensive conservation plan, the refuge would provide additional access to the banks, conduct baseline inventories, develop and implement a management plan, and perform water quality analysis in order to provide a quality fishing experience.

Availability of Resources: Based on a review of the refuge's budget allocated for this activity, there is adequate funding to ensure compatibility and to administer the use at its current level. Additional fiscal resources are needed to conduct this use as proposed. To improve sport-fishing opportunities, the plan includes proposals for additional access and water quality analyses.

Anticipated Impacts of the Use: Recreational fishing should not adversely affect the fisheries resource, wildlife resource, endangered species, or any other natural resource of the refuge. There may be some limited disturbance to certain species of wildlife and some trampling of vegetation; however, this should be short-lived and relatively minor and would not negatively impact wetland values of the refuge (Korschgen and Dahlgren 1992). If the refuge staff identifies wildlife disturbance at these sites as a problem in future years, they would close the areas during sensitive seasons to eliminate this concern.

Improvement of access would create some disturbance to the natural environment during construction and lead to increased public use on the State and refuge waters. The staff would carry out all construction activities with appropriate permits under Section 404 of the Clean Water Act and after State Historic Preservation Officer review of cultural resources. Engineers would incorporate soil stabilization features into the design of access points to minimize any future soil erosion potential and contractors would use sediment retention barriers during access improvement. Public use of the waters would increase as a result of improved access, but the level of use would not be expected to cause detrimental wildlife disturbance. Law enforcement activities would control the problems associated with littering and illegal take of fish. Providing information to refuge visitors about rules and regulations, along with increased law enforcement patrol, would keep these negative impacts to a minimum.

**Determination (check one below):**

_____ Use is Not Compatible

_X_ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility: Conflicts between fishermen and hunters or other visitors using the refuge for non-consumptive wildlife recreation have not been a problem in the past and are not expected to be a problem in the future. A continued law enforcement presence can minimize associated violations, such as the taking of under-sized fish, open fires, and littering. Following completion of the comprehensive conservation plan, the refuge staff would develop a Fishing Plan. The following stipulations would help to ensure that the refuge fishing program is compatible with refuge purposes.

All fishing tackle must be attended at all times.
Leaving boats on the refuge overnight is prohibited.
Fishing allowed during daylight hours only.

Justification: Refuge regulations permit fishing of State and refuge waters under State regulations. The goal of recreational fishing is to provide a quality fishing experience on a sustainable basis. The 1997 National Wildlife Refuge System Improvement Act lists fishing as a priority public use activity that the Service should provide and expand where possible. Improved access facilities would reduce bank erosion and habitat disturbance, while providing additional quality fishing opportunities.

**Mandatory 10- or 15-year Re-evaluation Date:_____**

**Description of Use:**

*Wildlife Observation and Wildlife Photography*

Nonconsumptive wildlife observation uses, such as birdwatching, auto tour routes, hiking, and nature photography, are popular due to the area's proximity to Virginia Beach and the availability of access and facilities. It is estimated that 70,000 visits per year are attributed to wildlife observation and related activities.

The staff anticipates that an increase in nonconsumptive wildlife-dependent uses would occur over the next few years as facilities and access are improved and especially as the public and conservation groups become more aware of the excellent birding and wildlife viewing opportunities on the refuge.

There are 9.2 miles of refuge roads maintained for public vehicle travel. The refuge has two trails on gravel roads for pedestrians and bicyclists, the 3.8-mile Mackay Island Trail and 6.5-mile Live Oak Point Trail. The refuge maintains the 0.3-mile Great Marsh Trail for pedestrians. Proposed road and trail upgrades are shown in Figure 7 of the draft comprehensive conservation plan.

Availability of Resources: Based on a review of the refuge's budget allocated for this activity, there is adequate funding to ensure compatibility and to administer the use at its current level. The refuge needs additional fiscal resources to provide this use as proposed. To provide safe, quality wildlife observation and photography opportunities, the Service would improve vehicular road access, develop wildlife observation points, and provide directional and interpretive signage.

Anticipated Impacts of the Use: Wildlife observation and wildlife photography activities could result in some disturbance to wildlife, especially if visitors venture too close to bald eagle nests, colonial nesting bird rookeries, and resting waterfowl in migration. The staff would prohibit visitors from traveling in areas around nest, rookeries, and managed wetlands. The refuge would locate refuge road systems, foot trails, boardwalks, and wildlife observation platforms, opened to pedestrian use by the public, to minimize disturbance that could occur in these sensitive areas (Korschgen and Dahlgren 1992). If the staff identifies unacceptable levels of disturbance at any time, they would close sensitive sites to public entry. Some minimal trampling of vegetation also may occur.

Construction of foot trails, boardwalks, observation platforms, and upgrading refuge roads would alter small portions of the natural environment. Proper planning prior to construction, sediment retention, and grade stabilization features would reduce negative impacts to wetlands, threatened and endangered species, and species of special concern. Impacts, such as trampling of vegetation and wildlife disturbance by refuge visitors, do occur, but are presently not significant. Upgrading refuge roads would reduce soil erosion associated with the current dirt roads and trails. Visitors can cause other potential negative impacts by violating regulations such as littering or illegally taking plants or wildlife. Use of refuge roads by the public does incur added maintenance costs.

**Determination (check one below):**

_____ Use is Not Compatible

_X_ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility: Prior to construction, the staff would obtain permits from local, state, and federal regulatory agencies to reduce the possibility of negatively impacting wetlands, cultural resources, or protected species. Law enforcement patrol of public use areas would continue to minimize violations of refuge regulations. The staff would close refuge roads to the public during nesting seasons and migratory waterfowl seasons to minimize wildlife disturbance. The staff would monitor public use for wildlife observation and wildlife photography to document any negative impacts. If any negative impacts become noticeable, the Service would take corrective action to reduce or eliminate the effects on wildlife.

Justification: Wildlife observation and wildlife photography are important and preferred public uses on Mackay Island National Wildlife Refuge and the National Wildlife Refuge System. The 1997 National Wildlife Refuge System Improvement Act identified wildlife observation and wildlife photography as priority pubic recreational uses that refuges should facilitate. It is through permitted, compatible public uses that the public becomes aware of and provides support for our national wildlife refuges.

**Mandatory 10- or 15-year Re-evaluation Date:_____**

**Description of Use:**

*Environmental Education and Interpretation*

Environmental education and interpretation are those activities that seek to increase the public's knowledge and understanding of wildlife, national wildlife refuges, ecology and land management, as well as contribute to the conservation of natural resources. When the comprehensive conservation plan is enacted, the refuge would develop interpretation and environmental education programs. Environmental education and interpretation activities have been largely nonexistent in prior years. The refuge staff plans to develop this program with structured activities conducted by the staff or trained volunteers. The staff would develop and provide curriculum and support materials to area teachers for use both on and off the refuge. They would also develop informational kiosks and interpretive panels at key refuge entrance points, and construct wildlife observation platforms as part of the environmental education and interpretation program.

Availability of Resources: Based on a review of the refuge's budget allocated for these activities, funding is inadequate to ensure compatibility and to administer these uses at current levels. The refuge needs additional fiscal resources to conduct these uses at the proposed levels. Current staffing is extremely limited with no public use staff. The management of a volunteer program would be essential to successfully implement the education and visitor use program. The refuge staff would recruit and train volunteers to assist in developing and implementing environmental education and interpretive programs. The refuge needs a permanent public use specialist and additional facilities, including access roads, boardwalks, signs, parking and trailhead development, kiosks, and environmental education materials to provide and conduct wildlife observation, wildlife photography, and environmental education and interpretation activities.

Anticipated Impacts of the Use: Construction of facilities such as boardwalks, kiosks, and observation platforms would alter small portions of the natural environment on the refuge. Proper planning and placement of facilities would ensure that wetlands, threatened or endangered species, or species of special concern are not negatively impacted. The refuge staff would obtain proper permits through the county, state, and federal regulatory agencies prior to construction to ensure resource protection. The use of on-site, hands-on, action-oriented activities to accomplish environmental education and interpretive tours may impose a low-level impact on the sites used for these activities. These low-level impacts may include trampling of vegetation and temporary disturbance to wildlife species in the immediate area (Korschgen and Dahlgren 1992). Educational activities held off of the refuge would not create any biological impacts on the resource.

**Determination (check one below):**

_____ Use is Not Compatible

__X__ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility: Zoning of visitor activities by time and space, clustering public use facilities, proper monitoring, educating visitors, and enforcement would ensure compatibility with the purposes of the refuge and mission of the National Wildlife Refuge System. Through periodic evaluation of trails and visitor contact points, the visitor services program would assess resource impacts. If the refuge staff determines that human impacts are detrimental to important natural resources, the staff would take actions to reduce or eliminate those impacts. Major portions of the refuge would remain undeveloped, without public interpretive facilities.

Justification: The 1997 National Wildlife Refuge System Improvement Act identified interpretation and environmental education as activities that refuges should provide and expand. Educating and informing the public through structured environmental education courses, interpretive materials, and guided tours about migratory birds, endangered species, wildlife management, and ecosystems would lead to improved support of the Service's mission to protect our natural resources.

**Mandatory 10- or 15-year Re-evaluation Date:_____**

**Description of Use:**

*Trapping of Selected Furbearers for Management*

The staff may direct management through trapping of raccoon and nutria. The species are at a sufficiently high level on the refuge to adversely affect ecosystem functions. Excessive numbers of raccoons can have negative effects on the reproduction of forest breeding birds and wood ducks. Nutria are exotic animals that consume great quantities of marsh grass and burrow into dikes of managed wetlands (moist-soil units). Protection and management of habitat and improvements in game and nongame populations are central components of the plan. To this end, trapping and/or hunting remain the only viable methods to reduce population levels of raccoon and nutria. The Service would issue Special Use Permits to administer a trapping program consistent with sound biology, refuge purposes, and conservation of ecosystem functions.

Availability of Resources: Additional resources are needed to conduct this use. The existing staff cannot administer permits and monitor this use as part of routine management duties.

Anticipated Impacts of the Use: Targeted removal of raccoon and nutria from portions of the refuge would reduce the negative impacts these species are having on ecosystem functions. Regulated trapping of raccoon populations would reduce the nest predation this species causes to neotropical birds and wood ducks. Nutria management would protect marsh grass and dikes of managed wetlands (moist-soil units). However, no trapping program, regardless of how well it is designed, can prevent the possible take of other species. The staff would require trappers to report the incidental take of other species. There would be a negligible impact on other wildlife species in both the short- and long-term.

**Determination (check one below):**

_____ Use is Not Compatible

__X__ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility: As the refuge staff implements a trapping program on the refuge, it would monitor the program closely to assess the potential adverse effects on other wildlife, as well as the benefits to game and nongame species and their habitats. The staff would modify the program as needed to maintain compatibility. Trappers would carry out all trapping activities under a Special Use Permit. The staff would limit trappers by number, area, and season in order to target problem areas and minimize any negative impacts. The staff would require each trapper to report the number and location of all traps and all wildlife taken. The implementation of a trapping program, under controlled conditions, provides an essential population control management tool and is compatible with the purposes of the refuge.

Justification: The purposes of Mackay Island National Wildlife Refuge emphasize conservation of wetlands and migratory birds. Trapping is a wildlife population management tool used to regulate the population of certain wildlife species when those species are disrupting ecosystem functions. There is documentation that raccoons cause negative impacts to forested wetlands and nesting birds. Nutria are exotic animals that cause negative impacts on marsh grass and the dikes of managed wetlands (moist-soil units). When these negative impacts become significant on the refuge, wildlife managers need trapping as a management tool to control the level on damage. Certainly, the native raccoons are important components of the ecosystem, but when their populations and negative impacts become significant, wildlife managers need a regulated trapping program to reduce their populations to acceptable levels.

**Mandatory 10- or 15-year Re-evaluation Date:_____**

Description of Use:

*Forest Management Program*

Mackay Island National Wildlife Refuge would initiate a forest management program in accordance with an approved forest management plan that a contractor would develop when the Service allocates the funds for a contract. The staff would direct forest management, as described in the draft comprehensive conservation plan, towards protecting, restoring and managing the functions and values of the refuge forest to support viable populations of native flora and fauna consistent with sound biological principles.

The staff would inventory and map the entire refuge forest habitat as part of the development of a forest management plan. This plan would provide a comprehensive forest management prescription to achieve forest habitat objectives over a 15-year planning cycle. Forest management prescriptions would include prescribed fire, timber stand improvement, commercial timber harvest, and reforestation.

The staff would manipulate forest habitat by prescribed fires conducted by Fish and Wildlife Service staff and commercial timber harvests. Contractors would conduct all harvesting by Special Use Permit and carry it out in accordance with the Refuge Manual. The staff would carry out the sale and disposition of forest products by open market rules and formal bid solicitations.

Availability of Resources: Based on a review of the refuge's budget allocated for this activity, there is not adequate funding to ensure compatibility and to administer the current forest management program, which consists of prescribed burning, thinning, water management, and fire protection. The comprehensive conservation plan proposes a forest management program that would utilize timber harvest to promote the enhancement of habitats for both threatened and endangered species, migratory birds and resident wildlife; promote habitat restoration; protect cultural resources; and provide opportunities for public recreation and environmental education. Managing the forest would require additional funding and staffing to inventory forest stands, prepare a forest management plan, develop forest prescriptions, and administer timber harvest.

Anticipated Impacts of the Use: It is anticipated that forest habitat management would enhance the existing forest and help restore the functions and values typically associated with coastal fringe evergreen forest and mesic pine flatwood forest, both of which are comprised of mixed pine and hardwood trees. The staff would conduct prescribed burning to mimic natural fire frequencies and maintain understory conditions for wildlife species (Frost 1995, 1998). It would also direct forest management operations at providing more vertical diversity (e.g., understory, midstory, canopy and superemergent trees) within each forest block in support of the habitat requirements of forest dwelling birds and other resident wildlife.

Forest management would include the use of prescribed burning that, if not tightly controlled and supervised, has the potential to cause adverse impacts on environmental quality. The controls placed on prescribed burning minimize possible adverse effects on air quality from smoke and particulates and adjoining habitats and houses from fire. However, minimum short-term impacts do occur from prescribed burning, such as loss of cover from standing shrub and perennial herbaceous cover. Perennial herbaceous plants recover quickly from fire. The herbaceous plants produce substantially more palatable browse for wildlife than the shrubs controlled by the burning. Certain wildlife species, such as red-cockaded woodpeckers, prefer the open understory in their habitat. The shrubs destroyed by fire in the forest stands burned in any given year is small in its extent compared to the shrub cover available in other stands on the refuge and unmanaged areas off the refuge.

Forest management would include the use of commercial timber harvest operations that, if not tightly controlled and supervised, have the potential to cause adverse impacts on environmental quality. The controls placed on harvesting operations minimize possible adverse effects caused by logging equipment, such as excessive defacement and negative impacts on surface water quality. However, minimum short-term impacts do occur from harvesting operations, such as actual mechanized operation disturbance to wildlife and trampling of the understory vegetation by equipment. The understory vegetation usually recovers in one growing season and usually is more beneficial to wildlife due to increased density and palatability caused by harvest operations (i.e., decreased competition and increased sunlight reaching the forest floor).

**Determination (check one below):**

_____ Use is Not Compatible

__X__ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility: The refuge would carry out commercial timber harvest operations only after the staff has completed a comprehensive forest inventory and prepared a Forest Habitat Management Plan. The staff would direct forest management operations at providing a desired future condition for the overall refuge forest. They would inventory individual forest stands, develop timber harvest prescriptions, and carry out timber harvest operations in a manner that would accomplish the refuge's forest habitat management objectives for migratory birds, threatened and endangered species, and resident wildlife. Timber harvest operations would target select trees to be sold, and then commercial timber and pulpwood operators would remove the timber. Those same operators may also remove trees through a timber stand improvement operation or permittees can harvest the trees when commercial sales are not feasible. Operators would only take trees needing to be removed in order to improve the forest habitat for wildlife or to restore the integrity of the forested wetlands ecosystem. The staff may conduct forest management operations throughout the year, but only according to the guidelines detailed in a Forest Habitat Management Plan.

Justification: The forest management actions proposed in the draft comprehensive conservation plan for Mackay Island National Wildlife Refuge are in accordance with Service guidelines for the protection, management, and enhancement of habitats for wildlife populations on the refuge. Adherence to a Forest Habitat Management Plan promotes the enhancement of habitats for threatened and endangered species, migratory birds and resident wildlife species; promotes habitat restoration; protects cultural resources; and provides opportunities for public recreation and environmental education.

**Mandatory 10- or 15-year Re-evaluation Date:_____**

**Description of Use:**

*Cropland Management Program*

Mackay Island National Wildlife Refuge manages cropland and grasslands to provide highly nutritious annual grain crops and browse for waterfowl, songbirds, and mammals. The crops provide grain for geese and swans, wheat browse for geese and white-tailed deer, and food and cover for mammals and neotropical migratory songbirds from perennial grasslands. The refuge would conduct a cropland management program in accordance with an approved management plan that the refuge staff has developed in consultation with biologists in the Service and the USDA, Natural Resources Conservation Service. The staff would direct cropland management towards providing grain and browse while protecting, restoring, and managing the functions and values of other habitats to support viable populations of flora and fauna consistent with sound biological principles.

The staff would evaluate the cropland vegetation on the refuge and adapt the existing management plan in response to the data. This plan provides a comprehensive management prescription to achieve cropland habitat objectives over a 15-year planning cycle. Cropland management prescriptions include crop rotations, tillage systems, nutrient management, and integrated pest management.

Availability of Resources: Based on a review of the refuge's budget allocated for this activity, there is not adequate funding for the staff to evaluate the impacts of the croplands and make recommendations for adaptive management. The staff currently relies on biologists from other refuges and the Migratory Bird Field Office to evaluate the impacts and recommend changes in management. The draft comprehensive conservation plan proposes a cropland management program that would supplement the natural habitats for both migratory birds and resident wildlife, protect cultural resources, and provide opportunities for public recreation and environmental education. Evaluating the impacts of croplands and adapting management without assistance from other offices would require additional funding and staffing.

Anticipated Impacts of the Use: It is anticipated that cropland management would supplement the natural habitats on the refuge (Ringelman 1990). The staff would direct cropland management operations at providing more types of grain and the proper balance of grain to browse from crops that meet the food cover requirements of the wildlife species of concern. The staff would monitor cooperative farmers' compliance with the annual cooperative farming agreement that specifies crops to be planted, dates of planting, crops to be left in the field unharvested, pesticides to be used, and pesticide application techniques to be used..

The operations include tillage and the applications of nutrients and pesticides that enhance crop production, but that may cause non-point pollution. Tillage performed in accordance with a conservation plan developed by the USDA, Natural Resources Conservation Service, should not cause erosion that would result in sedimentation into aquatic ecosystems or carry nutrients or pesticides into those ecosystems. Nutrient management in accordance with soil test reports specifying the rates, timing, and formulations of nutrients should not cause runoff or percolation of nutrients. Pest management in accordance with an integrated pest management plan should result in scouting to assess pest problems and consideration of mechanical, cultural, and chemical techniques to control pests. Application of chemical pesticides in accordance with label directions should minimize the drift, runoff, and percolation of pesticides into the environment.

The minimum short-term impacts from cropland management operations include soil disturbance by disking, and the loss of standing cover of weed species by mowing, disking, and herbicide application. The sown crops quickly cover the soil disturbed by tillage and produce grain and browse

selected to supplement natural habitats. Rotating crops throughout the cropland acreage minimizes the need for fertilizer and pesticides, and alternates the heavy residue-producing crops (e.g., corn) with poor residue-producing crops (e.g., soybeans). The standing herbaceous cover disturbed in the cropland is close to the cover available from the perennial cover in field borders and in the undisturbed marshes and forests surrounding the cropland.

**Determination (check one below):**

_____ Use is Not Compatible

__X__ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility: The refuge would carry out the cropland management in accordance with a management plan that specifies crops, crop rotation, tillage, nutrient management, and pest management. The staff would direct cropland management operations at supplementing natural habitats throughout the South Atlantic Coastal Plain. They would evaluate the impacts of the cropland, revise cropland management agreements, and carry out cropland management operations in a manner that would accomplish the refuge's cropland management objectives for migratory birds and resident wildlife.

Justification: The cropland management actions proposed in the draft comprehensive conservation plan for Mackay Island National Wildlife Refuge are in accordance with Service guidelines for the protection, management, and enhancement of habitats for wildlife populations on the refuge. Adherence to the Cropland Management Plan supplements the natural habitats for both migratory birds and resident wildlife species; protects cultural resources; and provides opportunities for public recreation and environmental education.

**Mandatory 10- or 15-year Re-evaluation Date:_____**

**Description of Use:**

*Refuge Resource Research Studies*

This activity would allow university students and professors, non-governmental researchers and governmental scientists, access to the refuge's natural environment to conduct both short-term and long-term research projects. The outcome of this research would result in better knowledge of our natural resources and improved methods to manage, monitor, and protect refuge resources. The refuge would support Fish and Wildlife Service and U.S. Geological Survey research of neotropical migratory birds, waterfowl, bottomland hardwood restoration, amphibians and reptiles, forest bats, and yellow-crowned night herons. The refuge would make efforts to expand partnerships with North Carolina State University and other area universities to conduct research on the refuge associated with neotropical migratory songbirds.

Availability of Resources: The refuge needs no additional fiscal resources to conduct this use if it is initiated by the university or agency conducting the research. Existing staff can administer permits and monitor use as part of routine management duties. Research initiated by the refuge would require funding through the Refuge Operations Needs System (RONS), Flex Fund Grants, or USGS Research Grants.

Anticipated Impacts of the Use: There should be no significant negative impacts from scientific research on the refuge. The knowledge gained from the research would provide information to improve management techniques and better meet the needs of trust resource species. Impacts such as trampling vegetation and temporary disturbance to wildlife would occur, but should not be significant. Researchers may collect a small number of individual plants or animals for further study. These collections would have an insignificant effect on refuge plant and animal populations.

**Determination (check one below):**

_____ Use is Not Compatible

__X__ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility: The staff would examine each request for use of the refuge for research on its individual merit. The questions of who, what, when, where, and why to determine if the requested research would contribute to the refuge purposes, and if the researchers could conduct it on the refuge without significantly affecting the resources, would be asked. If so, the refuge would issue a Special Use Permit to the researcher. The staff would monitor the progress and require the researcher to submit annual progress reports and copies of all publications derived from the research.

Justification: The benefits derived from sound research provide a better understanding of species and the environmental communities present on the refuge. These benefits far outweigh any short-term disturbance or loss of individual plant and animals that might occur.

**Mandatory 10- or 15-year Re-evaluation Date:_____**

Literature Cited

Bookhout, T.A.. 1994. Research and management techniques for wildlife and habitats. Fifth edition. The Wildlife Society, Bethesda, MD 740pp.

Eldridge, J. 1992. Management of habitat for breeding and migrating shorebirds in the Midwest.. In Laubhan, M.K., and D. Hamilton. Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Fort Collins, CO

Fredrickson, L.H. and M.E. Heitmeyer. 1988. Waterfowl Use of Forested Wetlands of the Southern United States: An Overview. Pages 307-323 in M.W. Weller, editor. Waterfowl in Winter. University of Minnesota Press, Minneapolis, Minnesota.

Fredrickson, L.H. and F. A. Reid. 1988. Nutritional value of waterfowl foods. In Laubhan, M.K., and D. Hamilton. Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Fort Collins, CO

Fredrickson, L.H. 1991. Strategies for water level manipulation in moist soil systems. In Laubhan, M.K., and D. Hamilton. Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Fort Collins, CO

Frost, C. 1995. Presettlement fire regimes in southeastern marshes, peatlands, and swamps. Pages 39-60 in Susan I. Cerulean and R. Todd Engstrom, eds. Fire in wetlands, a management perspective. Proceedings of the Tall Timbers Fire Ecology Conference, No. 19. Tall Timbers Research Station, Tallahassee, FL.

Frost, C. 1998. Presettlement fire frequency regimes in the United States: a first approximation. Pages 70-81 in Teresa L. Pruden and Leonard A. Brennan, eds. Fire in ecosystem management: shifting the paradigm from suppression to prescription. Proceedings of the Tall Timbers Fire Ecology Conference, No. 20. Tall Timbers Research Station, Tallahassee, FL.

Hunter, W.C., L.H. Peoples, and J.A. Collazo. 2001. South Atlantic Coastal Plain Partners in Flight Bird Conservation Plan.

Ringelman, J.K. 1990. Managing agricultural foods for waterfowl. In Laubhan, M.K., and D. Hamilton. Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Fort Collins, CO

Schmidt, P.R. 1993. Memorandum - Information request regarding impacts of hunting on national wildlife refuges. U.S. Department of the Interior, Fish and Wildlife Service, Office of Migratory Bird Management, Washington, D.C. 7pp.

**Approval of Compatibility Determination**

The signature of approval is for all compatibility determinations considered within the comprehensive conservation plan. If one of the descriptive uses is considered for compatibility outside of the comprehensive conservation plan, the approval signature becomes part of that determination.

**Refuge Manager:** _____
(Signature/Date)

**Regional Compatibility Coordinator:** _____
(Signature/Date)

**Refuge Supervisor:** _____
(Signature/Date)

**Regional Chief, National Wildlife Refuge System, Southeast Region:** _____
(Signature/Date)

# *VI. Refuge Biota*

**Animals - Birds**
A = Abundant, C = Common, U = Uncommon, O = Occasional, R = Rare

| ANIMALS | | | | |
|---|---|---|---|---|
| **SPECIES** | **SPRING** | **SUMMER** | **FALL** | **WINTER** |
| **BIRDS (Total Species - 187, Breeding Species - 60)** | | | | |
| Bittern, American* | U | U | U | U |
| Bittern, Least* | U | U | U | U |
| Blackbird, Red-winged* | C | C | C | C |
| Bluebird, Eastern | O | O | O | |
| Bobolink | O | | | |
| Bobwhite, Northern* | C | C | C | C |
| Bufflehead | | | O | U |
| Bunting, Indigo | U | U | | |
| Canvasback | O | | O | O |
| Catbird, Gray* | U | U | U | U |
| Cardinal, Northern* | C | C | C | C |
| Chickadee, Carolina* | C | C | C | C |
| Chuck-will's Widow* | U | U | | |
| Cormorant, Double-crested | O | O | C | C |
| Coot, American* | C | R | C | C |
| Cowbird, brown-headed* | C | C | C | C |
| Creeper, Brown | O | | | O |
| Crow, common* | C | C | C | C |
| Crow, Fish | U | U | U | |
| Cuckoo, black-billed | | R | R | |
| Cuckoo, Yellow-billed* | C | C | C | |
| Dove, Mourning* | C | C | C | C |
| Dove, Rock | O | O | O | O |
| Dowitcher, Short-billed | O | | | |

| ANIMALS | | | | |
|---|---|---|---|---|
| **SPECIES** | **SPRING** | **SUMMER** | **FALL** | **WINTER** |
| **BIRDS** | | | | |
| Duck, American Black* | C | O | C | C |
| Duck, Ring-necked | | | U | U |
| Duck, Ruddy | | | C | C |
| Duck, Wood* | C | C | C | U |
| Dunlin | O | | | |
| Eagle, Bald* (Threatened) | O | | O | O |
| Eagle, Golden | | | R | R |
| Egret, Cattle | C | C | O | |
| Egret, Great | C | C | C | C |
| Egret, Snowy | U | U | O | O |
| Falcon, Peregrine | | O | O | |
| Finch, Purple | O | | O | O |
| Flicker, Common* | C | C | A | C |
| Flycatcher, Great Crested* | C | U | | |
| Gadwall | | | A | A |
| Gallinule, Purple | R | R | | |
| Gnatcatcher, Blue-gray | R | R | | |
| Goldeneye, Common | | | R | R |
| Goldfinch, American | U | U | | |
| Goose, Canada* | O | O | U | U |
| Goose, Snow | C | R | C | A |
| Grackle, Boat-tailed | C | C | C | C |
| Grackle, Common* | C | C | C | C |
| Grebe, Horned | O | | | |
| Grebe, Pied-billed | O | O | O | O |
| Grebe, Red-billed | | | | R |
| Grosbeak, Blue | U | U | | |
| Grosbeak, Rose-breasted | O | | O | O |

| ANIMALS | | | | |
|---|---|---|---|---|
| **SPECIES** | **SPRING** | **SUMMER** | **FALL** | **WINTER** |
| **BIRDS** | | | | |
| Gull, Bonaparte's | | | O | O |
| Gull, Great Black-backed | U | | U | U |
| Gull, Herring | U | U | U | U |
| Gull, Laughing | U | U | C | C |
| Gull, Ring-billed | U | | U | U |
| Harrier, Northern | C | | C | C |
| Hawk, Broad-winged | | U | U | |
| Hawk, Cooper's | O | | U | U |
| Hawk, Red-shouldered | O | O | O | O |
| Hawk, Red-tailed* | U | U | U | U |
| Hawk, Rough-legged | | | R | |
| Hawk, Sharp-shinned | | U | U | U |
| Heron, Great Blue* | C | C | C | C |
| Heron, Green* | R | | | |
| Heron, Green-backed* | C | U | U | R |
| Heron, Little Blue | U | U | O | |
| Heron, Black-crowned Night | | O | O | O |
| Heron, Tri-colored | | O | O | O |
| Heron, Yellow-crowned Night | | R | R | R |
| Hummingbird, Ruby-throated* | U | U | | |
| Ibis, Glossy | U | U | O | O |
| Ibis, White | | R | | |
| Jay, Blue* | U | U | C | U |
| Junco, Dark-eyed | U | | U | U |
| Kestrel, American | C | | C | C |
| Killdeer | U | U | U | O |
| Kingbird, Eastern* | U | C | U | |
| Kingfisher, Belted* | C | C | C | C |

| ANIMALS | | | | |
|---|---|---|---|---|
| **SPECIES** | **SPRING** | **SUMMER** | **FALL** | **WINTER** |
| **BIRDS** | | | | |
| Kinglet, Ruby-crowned | O | O | O | |
| Loon, Common | | | O | O |
| Loon, Red-throated | | | R | R |
| Mallard* | C | U | C | C |
| Martin, Purple* | U | C | | |
| Meadowlark, Eastern* | C | C | C | C |
| Merganser, Hooded* | R | R | U | U |
| Merganser, Red-breasted | R | R | U | U |
| Merlin | | | O | O |
| Mockingbird, Northern* | C | C | C | C |
| Moorhen, Common* | C | C | C | U |
| Nighthawk, Common* | R | R | | |
| Nuthatch, White-breasted | | U | U | |
| Oriole, Northern | O | | | |
| Oriole, Orchard* | U | U | | |
| Osprey* | C | C | C | |
| Ovenbird | O | | | |
| Owl, Barred | | | R | R |
| Owl, Common Barn | R | R | R | R |
| Owl, Eastern Screech | C | C | C | C |
| Owl, Great Horned* | U | U | U | U |
| Owl, Short-eared* | R | R | R | R |
| Owl, Snowy | | | R | R |
| Phoebe, Eastern | | | C | |
| Pintail, Northern | O | | C | C |
| Plover, Black-bellied | R | | | |
| Plover, Semipalmated | O | | | |
| Rail, Black* | R | R | R | R |

| ANIMALS | | | | |
|---|---|---|---|---|
| **SPECIES** | **SPRING** | **SUMMER** | **FALL** | **WINTER** |
| **BIRDS** | | | | |
| Rail, King* | C | C | C | C |
| Rail, Virginia* | U | U | U | U |
| Redhead | | | U | U |
| Redstart, American | | | U | |
| Robin, American* | O | U | U | O |
| Sandpiper, Least | O | | O | O |
| Sandpiper, Semipalmated | U | | U | O |
| Sandpiper, Solitary | R | | | |
| Sandpiper, Spotted | U | O | U | O |
| Sandpiper, Western | R | | | |
| Sapsucker, Yellow-bellied | O | O | O | O |
| Scaup, Greater | | | R | R |
| Scaup, Lesser | O | | U | U |
| Shoveler, Northern | U | | U | U |
| Sora* | O | O | O | O |
| Snipe, Common | U | | U | U |
| Sparrow, Chipping | O | | C | |
| Sparrow, Field | C | | | C |
| Sparrow, Fox | | | | U |
| Sparrow, Savannah* | C | C | C | C |
| Sparrow, Sharp-tailed | | R | | |
| Sparrow, Song* | C | | C | C |
| Sparrow, Swamp | | | C | C |
| Sparrow, White-crowned | | | O | |
| Sparrow, White-throated | C | | C | C |
| Starling, European* | C | C | C | U |
| Stilt, Black-necked | R | | | |
| Swallow, Barn | C | C | C | |

| ANIMALS | | | | |
|---|---|---|---|---|
| **SPECIES** | **SPRING** | **SUMMER** | **FALL** | **WINTER** |
| **BIRDS** | | | | |
| Swallow, Northern Rough-winged | R | R | R | |
| Swallow, Tree | C | C | A | O |
| Teal, American Green-winged | C | | C | C |
| Teal, Blue-winged | C | | C | C |
| Tern, Black | | U | | |
| Tern, Caspian | O | O | O | |
| Tern, Common | U | C | U | |
| Tern, Forster's | | R | O | O |
| Tern, Least | | O | O | |
| Tern, Royal | R | R | | |
| Tern, Sooty | | | R | |
| Thrasher, Brown* | C | C | C | C |
| Thrush, Hermit | | | | U |
| Titmouse, Tufted* | U | C | C | |
| Towhee, Rufous-sided* | C | | | C |
| Turnstone, Ruddy | R | | | |
| Vireo, Red-eyed* | O | O | | |
| Vireo, White-eyed* | U | C | | |
| Vulture, Black | R | R | O | O |
| Vulture, Turkey | C | C | A | A |
| Warbler, Black-and-white | | | R | |
| Warbler, Black-throated Green | O | | | |
| Warbler, Blackpoll | O | | | |
| Warbler, Hooded | O | | | |
| Warbler, Magnolia | O | | | |
| Warbler, Northern Parula | R | | | |
| Warbler, Palm | | | C | |
| Warbler, Pine | R | | | |

| ANIMALS | | | | |
|---|---|---|---|---|
| **SPECIES** | **SPRING** | **SUMMER** | **FALL** | **WINTER** |
| **BIRDS** | | | | |
| Warbler, Prairie* | C | C | | |
| Warbler, Prothonotary* | C | C | O | |
| Warbler, Yellow | O | | | |
| Warbler, Yellow-rumped | C | | A | A |
| Warbler, Yellow-throated | O | R | | |
| Waxwing, Cedar | O | | O | O |
| Wigeon, American | U | | C | C |
| Wigeon, Eurasian | | | R | R |
| Willet | R | | | |
| Woodcock, American | O | R | O | R |
| Woodpecker, Downy | U | U | U | U |
| Woodpecker, Hairy | U | R | R | R |
| Woodpecker, Pileated* | U | U | U | U |
| Woodpecker, Red-bellied | U | U | U | O |
| Woodpecker, Red-cockaded* | R | R | | |
| Woodpecker, Red-headed | R | R | R | R |
| Wood-pewee, Eastern* | C | O | | |
| Wren, Carolina* | C | C | C | C |
| Wren, House* | U | U | O | |
| Wren, Marsh* | U | U | U | U |
| Yellow-throat, Common* | C | C | O | |
| Yellowlegs, Greater | O | | O | |
| Yellowlegs, Lesser | O | | O | R |

**species with confirmed breeding records*

| ANIMALS (continued) | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| **MAMMALS** | |
| Cottontail, Eastern | *Sylvilagus floridanus* |
| Deer, White-tailed | *Odocoileus virginianus* |
| Fox, Grey | *Urocyon cinereogrenteus* |
| Fox, Red | *Vulpes fulva* |
| Mink | *Mustela vison* |
| Mole, Eastern | *Scalopus aquaticus* |
| Mouse, Cotton | *Peromyscusgossypinus* |
| Mouse, Eastern Harvest | *Reithrodontomys humilis* |
| Mouse, House | *Mus musculus* |
| Mouse, White-footed | *Peromyscus leocopus* |
| Muskrat | *Ondathra zibethicus* |
| Nutria (Exotic) | *Myocastor coypus* |
| Opossum | *Didelphiidae virginiana* |
| Otter, River | *Lutra canadensis* |
| Rabbit, Marsh | *Sylvilagus palustris* |
| Raccoon | *Procyon lotor* |
| Rat, Marsh Rice | *Oryzomys palustris* |
| Rat, Norway (Exotic) | *Rattus norvegicus* |
| Shrew, Least | *Crytotis parva* |
| Shrew, Shorttail | *Blarina brevicauda* |
| Shrew, Southeastern | *Sorex longerosytris* |
| Squirrel, Eastern Grey | *Sciurus carolinensis* |
| Vole, Meadow | *Microtus pennsylvanicus* |
| **TURTLES** | |
| Cooter, Florida | *Chrysemys floridana floridana* |

| ANIMALS (continued) | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| **TURTLES** | |
| Mudturtle, Eastern | *Kinosternon subrubrum subrubrum* |
| Stinkpot | *Sternotherus odoratus* |
| Terrapin, Northern diamond back | *malaclemys terrapin terrapin* |
| Turtle, Chicken | *Deirochelys reticularia* |
| Turtle, Eastern box | *Terrapeme carolina carolina* |
| Turtle, Eastern Painted | *Chrysemys picta picta* |
| Turtle, Red-bellied | *Chrysemys rubiventris* |
| Turtle, Snapping | *Chelydra serpentina* |
| Turtle, Spotted | *Clemmys guttata* |
| Turtle, Yellow-bellied | *Chrysemys scripta scripta* |
| **SNAKES** | |
| Copperhead, Southern | *Agkistrodon contortrix* |
| Cottonmouth, Eastern | *Agkistrodon piscivorus* |
| Racer, Northern Black | *Coluber constrictor constrictor* |
| Rattlesnake, Canebrake | *Crotalus horridus atricaudatus* |
| Snake, Black Rat | *Elaphe obsoleta obsoleta* |
| Snake, Brown Water | *Natrix taxispilota* |
| Snake, Coastal Plain Milk | *Lampropeltis triangulum* |
| Snake, Corn | *Elaphe guttata guttata* |
| Snake, Eastern Garter | *Thamnophis sirtalis sirtalis* |
| Snake, Eastern hognose | *Heterdon platyrhinos* |
| Snake, Eastern King | *Lampropeltis getulus getulus* |
| Snake, Eastern Mud | *Farancia abacura abacura* |
| Snake, Eastern Ribbon | *Thamnophis sauritus sauritus* |
| Snake, Eastern Smooth earth | *Virginia valeriae* |
| Snake, Eastern Woods | *Carphophis amoenus amoenus* |

| ANIMALS (continued) | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| **SNAKES** | |
| Snake, Northern Brown | *Storeria dekayi dekayi* |
| Snake, Northern Scarlet | *Cemophora coccinea copei* |
| Snake, Northern Water | *Natrix sipedon sipedon* |
| Snake, Pine Woods | *Rhadinae flavilata* |
| Snake, Rainbow | *Farancia Erythrogram* |
| Snake, Red-Bellied | *Storeria occipitomaculata* |
| Snake, Red-Bellied Water | *Natrix erythrogaster erythrogaster* |
| Snake, Rough Earth | *Virginia striatulla* |
| Snake, Rough Green | *Opheodrys aestivus* |
| Snake, Southern Ringneck | *Diadophis punctatus punctatus* |
| **SALAMANDERS** | |
| Amphiuma, Two-toed | *Amphiuma means* |
| Newt, Red-Spotted | *Notophthalmus viridescens viridescens* |
| Salamander, Eastern Mud | *Pseudotriton montanus montanus* |
| Salamander, Eastern Tiger | *Ambystoma tigrinum tigrinum* |
| Salamander, Many-Lined | *Stereochilus marginatus* |
| Salamander, Marbled | *Ambystoma opacum* |
| Salamander, Red-Backed | *Plethodone Cinereus Cenereus* |
| Salamander, Slimy | *Plethodone glutinosus glutinous* |
| Salamander, Souther Dusky | *Desmognathus auriculatus* |
| Salamander, Spotted | *Ambystoma muculatum* |
| Siren, Greater | *Siren lacertina* |
| Waterdog, Dwarf | *Necturus punctatus* |
| **LIZARDS** | |
| Anole, Green (Carolina Anole) | *Anolis carolinensis* |

| ANIMALS (continued) | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| **LIZARDS** | |
| Lizard, Fence | *Sceloporus undulatus hyacinthinus* |
| Racerunner, Six-Lines | *Cnemidophorus sexlineatus* |
| Skink, Ground | *Leiolopisma laterale* |
| Skink, Five-Lined | *Eumeces fasciatus* |
| Skink, Broad-Headed | *Eumeces laticeps* |
| Skink, Southeastern Five-Lined | *Eumeces inexpectatus* |
| Lizard, Slender Glass | *Ophisaures attenuatus* |
| **FROGS AND TOADS** | |
| Bullfrog | *Rana catesbeiana* |
| Frog, Brimley's Chorus | *Pseudarcris brimleyi* |
| Frog, Carpenter | *Rana virgatipes* |
| Frog, Gray Tree | *Hyla chrysoscelis (diploid form)* |
| Frog, Gray Tree | *Hyla versicolor (polyploid form)* |
| Frog, Green | *Rana clamitans melanota* |
| Frog, Green tree | *Hyla gratiosa* |
| Frog, Northern Cricket | *Acris crepitans crepitans* |
| Frog, Northern Cricket | *Hyla crucifer crucifer* |
| Frog, Pickerel | *Rana palustris* |
| Frog, Pine Woods Tree | *Hyla femoralis* |
| Frog, Southern Cricket | *Acris gryllus gyrllus* |
| Frog, Southern Leopard | *Rana utricularia* |
| Frog, Squirell Tree | *Hyla squirella* |
| Frog, Upland Chorus | *Pseudarcris trisertiata feriarum* |
| Grog, Little Grass | *Limnaoedus ocularis* |
| Peeper, Northern Spring | *Hyla cinera cinera* |
| Spadefoot, Eastern | *Scaphiopus holbrooki holbrooki* |

| ANIMALS (continued) | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| **FROGS AND TOADS** | |
| Toad, Eastern Narrow-Mouthed | *Gastrophryne carolinensis* |
| Toad, Fowlers | *Bufo woodhousei fowleri* |
| Toad, Oak | *Bufo quercicus* |
| Toad, Southern | *Bufo terrestris* |
| **FISH** | |
| Alewife | *Alosa pseudorharengus* |
| Anchovy, Bay | *Anchoa mitchilli* |
| Bass, Largemouth | *Micropterus Salmoides* |
| Bass, Spotted | *Micropterus punctulatus* |
| Bass, Striped | *Morone saxatilis* |
| Bluegill | *Lepomis macrochirus* |
| Bowfin | *Amia Calva* |
| Bullhead, Black | *Ictalurus Melas* |
| Bullhead, Brown | *Ictalurus Nebulosis* |
| Bullhead, Yellow | *Ictalurus Natalis* |
| Carp | *Cyprinus Carpio* |
| Catfish, Channel | *Ictalurus Punctatus* |
| Catfish, White | *Ictalurus catus* |
| Chubsucker, Lake | *Erimzon sucetta* |
| Crappie, Black | *Pomoxis nigromaculatus* |
| Croaker, Atlantic | *Micropogon undulatus* |
| Drum, Red | *Sciaenps ocellata* |
| Drum, Star | *Stellifer lanceolatus* |
| Eel, American | *Anguilla Rostrata* |
| Fish, Lady | *Elops saurus* |
| Flier | *Centrarchus marcopterus* |

| ANIMALS (continued) | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| **FISH** | |
| Flounder, Southern | *Paralichthys lethostigma* |
| Flounder, Summer | *Paralichthys dentatus* |
| Gar, Longnose | *Lepisosteus osseus* |
| Goby, Darter | *Gobionellus boleosoma* |
| Goby, Naked | *Bogiosoma bosci* |
| Herring, Blueback | *Alosa aestivalis* |
| Killifish, Banded | *Fundulus diaphanus* |
| Killifish, Marsh | *Fundulus confluentus* |
| Madtom, Tadpole | *Noturus gyrinus* |
| Menhaden, Atlantic | *Brevoortia tyrannus* |
| Mullet, Striped | *Mugil cephalus* |
| Mullet, White | *Mugil curema* |
| Perch, Silver | *Bairdiella chrysura* |
| Perch, White | *Morone americana* |
| Perch, Yellow | *Perca flavescens* |
| Pickerel, Chain | *Esox niger* |
| Pickerel, Redfin | *Esox Americans* |
| Pinfish | *Lagodon rhomboides* |
| Pipefish, Gulf | *Syngnathus scovelli* |
| Pumpkinseed | *Lepomis gibbosus* |
| Seatrout, Spotted | *Cynoscion nebulosus* |
| Shad, American | *Alosa sapidissima* |
| Shad, Gizzard | *Dorosoma cepedianum* |
| Shiner, Golden | *Notemigonus crysoleucas* |
| Silverside, Tidewater | *Menidia beryllina* |
| Snapper, Gray | *Lutjanus griseus* |

| ANIMALS (continued) | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| **FISH** | |
| Spot | *Leiotomus xanthurus* |
| Sunfish, Bluespotted | *Enneacarthus gloriosus* |
| Warmouth | *Lepomis gulosus* |
| **INSECTS** | |
| Beatles, Whirligig | *Gyrinus sp.* |
| Beetle, Burrowing Water | *Suphisellus sp.* |
| Beetle, Water Scavenger | *Berosus sp.* |
| Beetle, Water Scavenger | *Derallus altus* |
| Bluets | *Enallagma durum* |
| Boatman, Water | *Corixa sp.* |
| Caddisflies | *Lepotoceridae* |
| Casemakers, Longhorned | *Oecetis sp.* |
| Damselfly, Common Blu | *Enallagma sp.* |
| Fork-Tail, Common | *Ischnura verticalis* |
| Mayfly | *Baetidae* |
| Midge | *Polypedium sp.* |
| Midge | *Tanytarsus sp.* |
| Pirate, Blue | *Pachydiplax longipennis* |
| Punkies, No-see-ums | *Palpomyia sp.* |
| Scorpion, Water | *Ranatra so.* |
| Waterscorpions | *Anax junius* |
| | *Arthripsodes sp.* |
| | *Coelotanypus concinnus* |
| | *Collotanaypus sp.* |
| | *Corethra sp.* |
| | *Cryptochironomus sp.* |

| ANIMALS (continued) | |
|---|---|
| Waterscorpions | *Paracymus nanus* |
| | *Prodladius sp.* |
| | *Tendipes riparius* |
| | *Tendipes sp.* |
| | *Triaenodes sp.* |
| | *Uvarus sp.* |

| FLORA | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| **TREES** | |
| Baldcypress | *Taxodium distichum* |
| Bay, Sweet | *Magnolia virginiana* |
| Cedar, Eastern Red | *Juniperus virginiana* |
| Cherry, Black | *Prunus serotina* |
| Chinaberry (Exotic) | *Melia azedarach* |
| Dogwood, Flowering | *Cornus florida* |
| Holly, American | *Ilex opaca* |
| Locust, Black | *Robinia pseudo-acacia* |
| Maple, Red | *Acer rubrum* |
| Maple, Silver | *Acer saccharinum* |
| Mulberry, Red | *Morus rubra* |
| Oak, Laurel | *Quercus laurifolia* |
| Oak, Water | *Quercus nigra* |
| Oak, Willow | *Quercus phellos* |
| Pecan | *Carya illinoensis* |
| Persimmon, Common | *Diospyros virginiana* |
| Pine, Loblolly | *Pinus taeda* |

| FLORA | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| **TREES** | |
| Sweetgum | *Liquidambar styraciflua* |
| Sycamore | *Platanus occidentalis* |
| Tree, Toothache | *Zanthoxylum clava-herculis* |
| Tupelo, Swamp | *Nyssa sylvatica var. biflora* |
| Willow, Black | *Salix nigra* |
| Wilow, Coastal Plain, Ward's, Swamp | *Salix caroliniana* |
| Wilow, Sandbar | *Salix exigua* |
| **SHRUBS** | |
| Bay, Red | *Persea borbonia* |
| Bayberry, Northern | *Myrica pensylvanica* |
| Blackberry, Serrate'Leaf | *Rubus argutus* |
| Blackberry, Sand | *Rubus cuneifolius* |
| Blueberry, Black Highbush | *Vaccinium atrococcum* |
| Blueberry, Elliott's | *Vaccinium elliotti* |
| Butterflybush (Exotic) | *Buddelja davidii* |
| Dewberry, Prickly | *Rubus flagellaris* |
| Elder, Marsh | *Iva imbricata* |
| Elderberry, American | *Sambucus canadensis* |
| Fetterbush, Swamp | *Leucothoe racemosa* |
| Groundsel Tree, High Tide Bush | *Baccharis halimifolia* |
| Holly, Yaupon | *Ilex vomitoria* |
| Huckleberry, Squaw | *Vaccinium stamineum* |
| Juniper, Chinese (Exotic) | *Juniperus chinense* |
| Juniper, Shore (Exotic) | *Juniperus conferta* |
| Maple, Japanese Red (Exotic) | *Acer palmatum* |

| FLORA | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| Oak, Dwarf | *Quercus prinoides* |
| **SHRUBS** | |
| Oak, Scrub | *Quercus marilandica* |
| Olive, Autumn (Exotic) | *Eleaegnus umbellata* |
| Privet, Chinese (Exotic) | *Ligustrum chinense* |
| Rose, Swamp | *Rosa palustris* |
| Shadbush, Serviceberry | *Amelanchier candensis* |
| Sumac, Winged | *Rhus copallina* |
| Waxmyrtle | *Myrica cerifera* |
| **WOODY VINES** | |
| Creeper, Virginia | *Parthenocissus quinquefolia* |
| Grape, Mascadine | *Vitis rotundifolia* |
| Grape, Pigeon | *Vitis cinerea var. floridana* |
| Greenbrier, Cat | *Smilax gluca* |
| Greenbrier, Common | *Smilax rotundifolia* |
| Greenbrier, Ear-leaf | *Smilax auriculata* |
| Greenbrier, Laurel-Leaf | *Smilax laurifolia* |
| Greenbrier, Saw | *Smilax bona-nox* |
| Honeysuckle, Coral | *Lonicera sempervirens* |
| Honeysuckle, Japanese (Exotic)l | *Lonicera japonica* |
| Ivy, Poison | *Rhus radicans* |
| Trumpetcreeper | *Campsis radicans* |
| Vine, Pepper | *Ampelopsis arborea* |
| Wisteria (Exotic) | *Wisteria chinensis* |
| **FORBS (BROADLEAF HERBACEOUS PLANTS)** | |
| Alligatorweed (Exotic) | *Alternanthera philoxeroides* |
| Arrowhead, Awl-leaf | *Sagittaria subulata* |

| FLORA | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| Arrowhead, Broadleaf | *Sagittaria latifolia* |
| Arrowhead, Bulltongue | *Sagittaria lancifolia* |
| Aster, Bushy | *Aster dumosus* |
| Aster, Slender | *Aster tenuifolius* |
| Beach Heath | *Hudsonia tomentosa* |
| Bean, Wild | *Strophostyles helvola* |
| Bedstraw, Catchweed | *Galium aparine* |
| Beggarticks, Smooth | *Bidens laevis* |
| Bladderwort | *Utricularia spp.* |
| Buttercup, Celery-Leaf | *Ranunculus sceleratus* |
| Buttonweed | *Diodia spp.* |
| Cactus | *Opuntia compressa* |
| Camphor Weed | *Pluchea purpurascens* |
| Centella | *Centella asiatica* |
| Cherry, Ground | *Physalis visocosa ssp. maritima* |
| Chickweed, Mouse-Ear | *Cerastium vicosum* |
| Clover, Crimson (Exotic) | *Trifolium incarnatum* |
| Clover, White (Exotic) | *Trifolium repens* |
| Cocklebur, Rough | *Xanthium strumarium* |
| Coontail | *Ceratophyllum demersum* |
| Cranesbill, Carolina | *Geranium carolinianum* |
| Cress, Bitter | *Cardamine hairsuta* |
| Cucumber, Creeping | *Melothria pendula* |
| Cudweed, Narrow-Leaf | *Gnaphalium purpureum var. falcatum* |
| **FORBS (BROADLEAF HERBACEOUS PLANTS)** | |
| Daisy Fleabane | *Erigeron canadensis* |
| Daisy, False | *Eclipta alba* |

| FLORA | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| Dandelion, Dwarf | *Krigia virginica* |
| Dock, Curly | *Rumex crispa* |
| Dock, Water | *Rumex verticillatus* |
| Dog Fennel, Small | *Eupatorium capillifolium* |
| Dropwort, Water | *Oxypolis rigidior* |
| Duckweed, Minute | *Lemna perpusilla* |
| Duckweed, Greater | *Spirodela polythiza* |
| Elephant's Foot | *Elephantopus nudatus* |
| Feather, Parrot | *Myriophyllum brasiliense* |
| Fimbry, Forked | *Fimbristylis dichotoma* |
| Fleabane | *Pluchea pupurascens* |
| Frogbit | *Limnobium spongia* |
| Frogfruit | *Lippia lanceolata* |
| Goldenrod, Anisescented | *Solidago odora* |
| Goldenrod, Rough-leaved | *Solidago rugosa* |
| Goldentop, Slender | *Euthamia tenuifolia* |
| Goldenrod, Sweet | *Euthamia graminifolia* |
| Grasswort, Carolina | *Lilaeopsis carolinensis* |
| Grasswort, Eastern | *Lilaeopsis chinensis* |
| Grounsel, Wooly | *Senecio tomentosus* |
| Hemlock, Poison | *Cicuta maculata* |
| Hempweed, Climbing | *Mikania scandens* |
| Horehound, Water | *Lycopus virginicus* |
| Hyssop, Water | *Bacopa monnieri* |
| **FORBS (BROADLEAF HERBACEOUS PLANTS)** | |
| Ironweed, Tall | *Vernonia gigantea* |
| Jessamine, Yellow | *Gelsemium sempervirens* |

| FLORA | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| Jimsonweed (Exotic) | *Datura stramonium* |
| Lespedeza, Sericea (Exotic) | *Lespedeza cuneata* |
| Lettuce, Wild | *Lactuca canadensis* |
| Lobelia, Downy | *Lobelia puberula* |
| Loosestrife, False | *Ludwigia alternifolia* |
| Mallow, Seashore | *Kosteletzkya virginica* |
| Marigold, Nodding Bur | *Bidens cernua* |
| Medic, Black (Exotic) | *Medicago lupalina* |
| Milfoil, Eurasian (Exotic) | *Myriophyllum spicatum* |
| Milfoil, Water | *Myriophyllum exalbescens* |
| Monarda, Dotted | *Monarda punctata* |
| Morningglory, Saltmarsh | *Ipomoea sagittata* |
| Mudflower, Shade | *Micranthemum umbrosum* |
| Mudwort, Awl-leaf | *Limosella subulata* |
| Nettle, Horse | *Solanum carolinense* |
| Niad | *Najas quadalupensis* |
| Pea, Partridge | *Cassia fasciculata* |
| Pearlwort, Trailing | *Sagina decumbens* |
| Pennywort, Water | *Hydrocotyle umbellata* |
| Pennywort, Floating | *Hydrocotyle ranunculoides* |
| Pennywort, False | *Centella asiatica* |
| Pickerelweed | *Pontederia cordata* |
| Pimpernel, Water | *Samolus parviflorus* |
| Pink, Sea | *Sabatia stellaris* |
| **FORBS (BROADLEAF HERBACEOUS PLANTS)** | |
| Pinweed, Hairy | *Lechea mucrontha* |
| Pinweed, Leggett's | *Lechea pulchella* |

| FLORA | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| Plantain, Pale Seed | *Plantago virginica* |
| Pondweed, Leafy | *Potamogeton foliosus* |
| Pondweed, Sago | *Potamogeton pectinatus* |
| Pondweed, Clasping-Leaf | *Potamogeton perfoliatus* |
| Pondweed, Bushy | *Najas flexilis* |
| Pondweed, Horned | *Zannichellia palustris* |
| Pondweeds | *Najas spp.* |
| Primrose, Evening | *Oenothera humifusa* |
| Primrose, Evening | *Oenothera laciniata* |
| Purslane, Water | *Ludwigia palustris* |
| Rabbit Tobacco | *Gnaphalium obtusifolium* |
| Ragweed, Annual | *Ambrosia artemisiifolia* |
| Redstem, Pink | *Ammania teres* |
| Rocket, American Sea | *Cakile edentula* |
| Rocket, Harper's Sea | *Cakile harperi* |
| Salad, Corn | *Valerianella radiata* |
| Sandmat, Seaside | *Chamaesyce polygonifolia* |
| Skullcap, Hyssop | *Scutellaria integrifolia* |
| Smartweed, Dotted | *Polygonum punctatum* |
| Sorrel, Sheep | *Rumex hastatulus* |
| Soybean (Exotic) | *Glycine max* |
| St. Andrews Cross | *Hypericum stragalum* |
| Starwort, Water | *Callitriche heterophylla* |
| Sweetclover, White | *Melilotus alba* |
| **FORBS (BROADLEAF HERBACEOUS PLANTS)** | |
| Tea, Mexican | *Chenopodium ambrosioides* |
| Thistle, Russian | *Salsola kali* |

| FLORA | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| Thistle, Yellow | *Cirsium horridulum* |
| Thoroughwort, Late-flowering | *Eupatorium hyssopifolium* |
| Toadflax | *Linaria canadensis* |
| Tresses, Ladies | *Spiranthes vernalis* |
| Violet, Bog White | *Viola lanceolata* |
| Watercress | *Nasturtium officinale* |
| Weed, Mermaid | *Proserpinaca palustris* |
| Wild Sensitive Plant | *Cassia nictitans* |
| Wintergreen, Spotted | *Chimaphila maculata* |
| Wort, St. Johns | *Hypericum hypericoides* |
| Yarrow, Common | *Achillea millefolium* |
| **GRASSES** | |
| Bahiagrass (Exotic) | *Paspalum notatum* |
| Barnyardgrass (Exotic) | *Echinochloa crusgalli* |
| Bermudagrass (Exotic) | *Cynodon dactylon* |
| Bluegrass, Annual | *Poa annua* |
| Bluestem, Bushybeard | *Andropogon glomeratus* |
| Bluestem, Little | *Schizachyrium scoparium* |
| Bluestem, Splitbeard | *Andropogon ternarius* |
| Broomsedge | *Andropogon virginicus* |
| Cordgrass, Big | *Spartina cynosuroides* |
| Cordgrass, Saltmeadow | *Spartina patens* |
| Cordgrass, Smooth | *Spartina alterniflora* |
| Corn | *Zea mays* |
| **GRASSES** | |
| Crabgrass (Exotic) | *Digitaria spp.* |
| Cutgrass, Rice | *Leersia oryzoides* |

| FLORA | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| Dallisgrass (Exotic) | *Paspalum dilatatum* |
| Deertongue | *Dichanthelium clandestinum* |
| Eelgrass | *Vallisneria americana* |
| Fescue, Tall (Exotic)l | *Lolium arundinaceum* |
| Foxtail | *Setaria virdis* |
| Grass, American Cupscale | *Sacciolepis striata* |
| Grass, Blue-eyed | *Sisyrinchium mucronatum* |
| Grass, Widgeon | *Ruppia maritima* |
| Grass, Yellow-eyed | *Xyris difformis* |
| Grass, Yellow-eyed | *Xyris jupicai* |
| Johnsongrass (Exotic) | *Sorghum halpense* |
| Knotgrass | *Paspalum distichum* |
| Maidencane | *Panicum hemitomom* |
| Millet (Exotic) | *Setaria spp.* |
| Orangegrass | *Hypericum gentianoides* |
| Orchardgrass (Exotic) | *Dactylis glomerata* |
| Panicgrass, Beaked | *Panicum anceps* |
| Panicgrass, Velvet | *Dichanthelium scoparium* |
| Panicum, Fall | *Panicum dichotomiflorum* |
| Plumegrass, Sugarcane | *Saccharum giganteum* |
| Reed, Common (Exotic) | *Phragmites australis* |
| Ryegrass, Annual (Exotic) | *Lolium multiflorum* |
| Saltgrass, Seashore | *Distichlis spicata* |
| Sawgrass | *Cladium jamaicense* |
| **GRASSES** | |
| Sorghum | *Sorghum bicolor* |
| Switchgrass | *Panicum virgatum* |

| FLORA | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| Watergrass | *Hydrochloa spp.* |
| Wheat (Exotic) | *Triticum aestivum* |
| Woodoats, Slender | *Chasmanthium laxum* |
| **GRASSLIKE PLANTS** | |
| Beakrush, Clustered | *Rhynchospora glomerata* |
| Beakrush, Loosehead | *Rhynchospora chalorocephala* |
| Bulrush, Softstem | *Scirpus validus* |
| Cattail, Common | *Typha latifolia* |
| Cattail, Narrow-leaf | *Typha angustifolia* |
| Cattail, Southern | *Typha domingensis* |
| Flatsedge, Slender | *Cyperus fillicinus* |
| Flatsedge, Strawcolored | *Cyperus strigosus* |
| Iris, Virginia | *Iris virginica* |
| Rush, Canada | *Juncus canadensis* |
| Rush, Turnflower | *Juncus biflorus* |
| Rush, Black Needle | *Juncus roemerianus* |
| Rush, Leathery | *Juncus coriaceus* |
| Rush, Soft | *Juncus effusus* |
| Sedge, Egg-bracted | *Carex ovalis* |
| Spikerush, Blunt | *Eleocharis obtusa* |
| Spikeruch, Dwarf | *Eleocharis parvula* |
| Spikerush, Foursquare | *Elocharis quadrangulata* |
| Spikerush, Small-Fruit | *Elocharis microcarpa* |
| Spikerush, Yellow | *Eleocharis flavescens* |
| **GRASSLIKE PLANTS** | |
| Threesquare, Common | *Scirpus pungens* |
| Threesquare, Olney | *Scirpus olneyi* |

| FLORA | |
|---|---|
| **COMMON NAME** | **SCIENTIFIC NAME** |
| Woolgrass | *Scirpus cyperinus* |
| **FERN** | |
| Fern, Cinnamon | *Osmunda cinnamomea* |
| Fern, Netted Chain | *Woodwardia areolata* |
| **MOSS** | |
| Moss, Spanish | *Tillandsia usneoides* |

# VII. Priority Bird Species and Their Habitats

| Species/Feature | Status[1] | Habitat | | |
|---|---|---|---|---|
| | | Brackish Marsh | Coastal Fringe Evergreen Forest | Managed Wetlands (Moist Soil Units) |
| Bald Eagle | FL | X | | X |
| Red-cockaded Woodpecker | FL | | X | |
| West Indian Manatee | FL | X | | |
| Sharp-tailed Sparrow | SC | X | | |
| Prairie Warbler | SC | | X | |
| Hooded Warbler | SC | | X | |
| Prothonotary Warbler | SC | | X | |
| Black-throated Green Warbler | SC | | X | |
| Yellow-throated Warbler | SC | | X | |
| Northern Parula | SC | X | X | |
| King Rail | SC | X | | |
| Snow Goose | SC | | | X |
| Tundra Swan | SC | | | X |
| Wood Duck | SC | | X | |
| American Black Duck | SC | | | X |
| Mallard | SC | | | X |
| American Wigeon | SC | | | X |
| Blue-winged Teal | SC | | | X |
| Green-winged Teal | SC | | | X |
| Ruddy duck | SC | | | X |
| Northern Pintail | SC | | | X |

*[1] FL=Federally-Listed, SC=Species of Management Concern*

# VIII. Budget Requests

**REFUGE OPERATION NEEDS SYSTEM (RONS) PROJECTS**

Projects are ordered by the project number the first two digits of which stand for the fiscal year the project was developed. The numbers are listed in the management alternatives.

Projects are listed as tier 1 projects that support approved critical mission or approved minimum staff or tier 2 projects that do not.

Stations ranks are listed for both Mackay Island and Currituck National Wildlife Refuges. Since both refuges are managed as one administrative unit, many projects listed as Currituck Refuge projects would benefit Mackay Island Refuge equally.

**Project 97004 Habitat Improvement for Waterfowl and Shorebirds**
First Time Request $130,000, Recurring Request $56,000
Station Rank - 6 (Currituck Refuge Tier 2)
This project would provide the funding to improve management on a 150-acre natural impoundment (flats) on Currituck Refuge and initiate and force account farming program on 250 acres of cropland on the Mackay Island Refuge. The refuge would install a pumping system to provide a dependable water supply to flood the impoundment and increase monitoring to manage the area for optimum migratory waterfowl and shorebird habitat. Currently, the impoundment does not have an adequate supply and is not monitored sufficiently due to access. The flooded impoundment would provide important feeding and resting habitat for waterfowl, shorebirds, wading birds, and other species. Ducks Unlimited's MARSH project funding of $30,000 is available to cost-share this project. This project would also provide a maintenance worker to convert the cooperative farming program at Mackay Island Refuge to a force account program. There is currently only one farmer available to enroll in the cooperative agreement and it is possible that he may discontinue his participation. At that time, the refuge would initiate a force account program. The primary purpose of this program would be to provide winter feeding habitat for migratory Canada geese and other waterfowl.

**Project 97006 Refuge Complex Biological Program Enhancement**
First Year Request $65,000, Recurring Request $63,000
Station Rank – 2 (Mackay Island Refuge Tier 1)
This project will provide the funding to employ a wildlife biologist to conduct annual studies of wildlife and their habitats essential to the management of the natural resources of Mackay Island and Currituck Refuges. The biologist would also gather, analyze, and summarize data needed for planning purposes, including information to be used in the comprehensive conservation planning process. Examples of work include, but are not limited to, monitoring waterfowl, water bird and songbird populations; surveying and protecting endangered species and their habitats; surveying and monitoring invasive species; water quality monitoring; and monitoring and mapping submerged aquatic vegetation in refuge impoundments. Much of this biologically is currently gathered sporadically or not at all. This project would help provide biological data that is currently not available for making compatibility determinations and other management and legal decisions.

**Project 97009 Cultural Resource Surveys**
One Time Request $80,000
Station Rank - 9 (Mackay Island Refuge Tier 2)
This project would provide the funding for a contract to conduct comprehensive archaeological resource surveys on Mackay Island and Currituck Refuges. The surveys would document historical use by Native Americans, European colonists, and other groups. The area of the refuges and the area surrounding the refuges have a rich history, primarily due to proximity to water and abundant natural resources. The survey would focus on Native American, early colonial, Revolutionary War, and Civil War cultural resources. The refuges need this survey to develop resource and public use plans and comprehensive conservation plans.

**Project 97011 Fire Management Program Improvements**
First Year Request $81,000, Recurring Request $2,000
Station Rank - 4 (Mackay Island Refuge Tier 2)
This project would provide the funding for a contract a multi-year (3-5 year) study on Mackay Island Refuge to evaluate the effects of the current prescribed fire program on marsh habitat. The refuge burns 1,500 to 2,000 acres of marsh habitat by prescription annually using a 3-year rotation. The staff needs additional information to determine if the prescribed fire program is meeting planned objectives, and if needed, to modify the scope and/or intensity of annual burns to better meet habitat management objectives.

**Project 97013 Interpretation, Education, and Outreach Program Development**
First Year Request $65,000, Recurring Request $53,000
Station Rank - 1 (Currituck Refuge Tier 1)
This project would provide the funding to employ a public use specialist (outdoor recreation planner) to develop and implement interpretation, education, and outreach programs to include development of interpretive materials, programs, and displays at Mackay Island and Currituck Refuges. The position would also develop and implement environmental education materials for local schools and civic organizations. Currently, the refuge is not adequately addressing outreach opportunities due to inadequate materials and staffing. Mackay Island and Currituck Refuges are on the edge of a large metropolitan area with more than one million residents. Requests for environmental education and interpretive programs are more than the current facilities and staff can accommodate.

**Project 99001 Phragmites Control**
First Year Request $43,000, Recurring Request $3,000
Station Rank - 1 (Mackay Island Refuge Tier 1)
This project would provide the funding to control exotic phragmites on Mackay Island and Currituck Refuges. This species quickly spreads in wetland habitats, forms dense stands, and essentially eliminates native plant species where these dense stands form. This weed has limited value for native wildlife. It currently covers approximately 200 acres of the refuges. This exotic plant would continue to expand in the refuges' extensive wetlands unless control measures are implemented. Ducks Unlimited partnered with the Service to control approximately 60 acres of this species in 1998, and will likely contribute to future efforts.

**Project 99003 Forest Management Plan Development**
One Time Request $67,000
Station Rank - 5 (Mackay Island Refuge Tier 2)
This project would provide the funding to inventory existing forest resources and contract for the development of forest management plans for Mackay Island and Currituck Refuges. The refuges have more than 2,750 acres of forest habitat that the staff has neither inventoried nor managed. The habitat is beginning to deteriorate due to lack of management (i.e., frequent disease outbreaks, wind damage).

**Project 99004 Administrative Management Improvement**
First Year Request $77,500, Recurring Request $44,000
Station Rank - 2 (Mackay Island Refuge Tier 2)
This project would provide the funding to employ a full-time office assistant to improve administrative operation and outreach for Mackay Island and Currituck Refuges. The staff for both refuges is six permanent and two seasonal employees. As the biological and public use programs expand, the workload would be more than one office assistant could handle. The current position handles budgeting, purchasing, time-keeping, and personnel, as well as all other clerical duties.

**Project 00001 Endangered Species and Wetland Management Program Enhancement**
First Year Request $65,000, Recurring Request $53,000
Station Rank - 2 (Currituck Refuge Tier 1)
This project would provide the funding to employ a biological technician to conduct annual studies and surveys of wildlife and their habitats essential to management of the natural resources of Mackay Island and Currituck Refuges. The technician would also gather, analyze, and summarize data needed for planning purposes, including information to be used in the comprehensive conservation planning process. Surveys and monitoring of threatened and endangered species include, but are not limited to, piping plovers, loggerhead sea turtles, and seabeach amaranth. Other duties include monitoring the impacts of feral animals and invasive species, and monitoring and mapping submerged aquatic vegetation in refuge impoundments. Much of this information is currently not being gathered and is impacting management's ability to make compatibility determinations and other management decisions.

**Project 00002 Outreach from Visitor Contact Station**
First Year Request $70,000, Recurring Request $16,000
Station Rank - 3 (Mackay Island Refuge Tier 1)
This project would provide the funding to develop new outreach tools to include displays, interpretive materials, and signs for the Visitor Contact Station. The project would also develop color brochures and pamphlets for each refuge and portable displays and presentation materials for local and regional events (i.e., festivals, exhibits, and workshops). Outreach is not adequately addressed due to inadequate materials. Mackay Island and Currituck Refuges are on the edge of a large metropolitan area with more than one million residents. Requests for environmental education and interpretation programs are more than current facilities can accommodate.

**Project 00003 Great Marsh Habitat Alteration Grazing Research and Restoration**
One Time Request $60,000
Station Rank - 6 (Mackay Island Refuge Tier 2)
This project would provide the funding for a college graduate student to research and evaluate the changes in marsh habitat beginning in the 1920s to the present. The student would compare current aerial photographs of the Middle Marsh area of Mackay Island NWR with historic photographs to determine the amount of habitat lost to open ponds. Goose grazing, nutria feeding, or other conditions may have caused the loss. The project would evaluate the causes and recommend a restoration plan. Small openings in the marsh may have enlarged over the years resulting in loss of habitat. If the loss continues unabated, it may become significant and restoration may become difficult or unlikely due to loss of soil.

**Project 00005 Water Quality Monitoring**
First Year Request $15,500, Recurring Request $6,500
Station Rank - 6 (Mackay Island Refuge Tier 1)
Combined Station Tier 1 Rank - 8 (Mackay Island and Currituck Refuges)
Combined Station Rank - 19 (Mackay Island and Currituck Refuges)
This project would provide the funding to purchase water quality monitoring equipment and fund water testing in refuge impoundments and mitigation area on the Mackay Island Refuge. The monitoring would evaluate the impact of impoundments on water quality and document habitat changes in the mitigation area. State Coastal Zone Permit requirements for the construction of the Kitchin Impoundment require intensive monitoring of specific water quality parameters.

**Project 00006 Migratory Bird Management**
Tier 1 Project
First Year Request $41,000, Recurring Request $35,000
Station Rank - 4 (Mackay Island Refuge Tier 1)
This project would provide the funding to provide an aircraft for additional waterfowl and shorebird surveys, contract neotropical migratory songbird and habitat surveys, and establish habitat enclosures on the Mackay Island and Currituck Refuges. The project would add six waterfowl surveys and six shorebird surveys that the refuge had discontinued due to rising costs. The surveys would contribute valuable information to regional and national databases. Little is known about the neotropical birds on Mackay Island and Currituck Refuges. This information would allow the staff to make sound management decisions. The project would fund two habitat surveys annually. It would allow an annual survey of the Swan Island Impoundment on Currituck Refuge to help make management decisions. The staff has not completed the survey in five years. The project would also fund habitat enclosures to monitor the impacts of wild horses on Currituck Refuge.

**Project 00009 Fire Management Program Expansion**
First Year Request $85,000, Recurring Request $69,000
Station Rank - 3 (Mackay Island Refuge Tier 2)
This project would provide the funding to employ a fire management specialist and purchase equipment to facilitate an expanded fire management program. The project would allow the Mackay Island and Currituck Refuges to increase the area of prescribed fire by 3,500 acres and respond to wildfires. Current acreage for the two refuges is approximately 12,000 acres. Both refuges are expanding and have a total acquisition boundary of 19,000 acres. More than half of the existing and proposed area on the refuges is brackish marsh. Proper management for the marsh is to administer prescribed burns on a 3-year rotation.

**Project 00010 Fisheries Survey**
One Time Request $20,000
Station Rank - 10 (Mackay Island Refuge Tier 2)
This project would provide the funding for a comprehensive survey of existing fisheries on Mackay Island Refuge. The survey would sample impoundments, bays, creeks, and canals on the refuge. There is little information on the existing fish populations. More than five trust species utilize the refuge. An evaluation is necessary to help determine management needs.

**Project 00011 Refuge Management Improvement**
First Time Request $65,000, Recurring Request $69,000
Station Rank - 5 (Currituck Refuge Tier 2)
This project would provide the funding to employ an assistant manager for Currituck Refuge. The assistant manager would oversee the daily management and biological program of an expanding refuge. The refuge has an active acquisition program. The manager and assistant manager at Mackay Island Refuge currently manage the Currituck Refuge office on Knotts Island, North Carolina. As the Currituck Refuge grows, it would become more and more difficult to manage the refuge from across the sound. When acquisition is complete, the refuge would span 25 miles from the North Carolina/Virginia State line to the Dare County line. The refuge is long and linear following the barrier island known as the Outer Banks in North Carolina.

**Project 00012 Fisheries Survey**
One Time Request $20,000
Station Rank - 8 (Currituck Refuge Tier 2)
This project would provide the funding for a comprehensive survey of existing fisheries on Currituck Refuge. The survey would sample impoundments, bays, creeks, and canals on the refuge. There is little information on the existing fish populations. More than five trust species utilize the refuge. An evaluation is necessary to help determine management needs.

**Project 00013 Exotic Nutria Control**
First Year Request $75,000, Recurring Request $74,000
Station Rank - 8 (Mackay Island Refuge Tier 2)
This project would provide the funding to employ a biological technician to establish a program to monitor and control the rapidly increasing nutria population on Mackay Island Refuge. The nutria is an exotic animal from South America. There is a substantial population on the refuge. These animals are damaging habitat and infrastructure. They burrow into dikes and levees, enlarge ponds, consume great quantities of marsh vegetation, and feed in farm fields. The population seems to be growing and the impacts are increasing. Failure to control this population would lead to the continuation of habitat destruction.

**Project 00014 Equipment Wash Rack**
First Year Request $18,000, Recurring Request $4,000
Station Rank - 5 (Mackay Island Refuge Tier 1)
This project would provide the funding to construct a vehicle and equipment wash rack behind the existing shop that would comply with environmental standards of the State of North Carolina. The staff currently washes equipment immediately behind the shop on a gravel and mud driveway; this site creates a large muddy area for several days. Mud, oil, and diesel fuel washes into the ground on the site in violation of state water quality standards.

**Project 00016 Feral Horse Impact Research**
First Year Request $25,000, Recurring Request $40,000
Station Rank - 3 (Currituck Refuge Tier 2)
This project would provide the funding for two studies on the impacts of feral horses on the habitat of Currituck Refuge. One would be an enclosure study to evaluate the habitat impacts resulting from the feral horses. The second would be a movement study to determine animal movements on a seasonal basis. Each would be an extensive 3-year research study. Currently a small herd of feral horses roam the outer bank areas north of Corolla, North Carolina. An intensive evaluation is needed to determine impacts and to make management recommendations. Due to the disjunct nature of the refuge, horses travel on and off the refuge year-round. Management options are limited by local regulations and sentiment about the horses. Failure to evaluate this threat may result in significant habitat impacts that could damage threatened and endangered species and migratory bird habitat.

**Project 00017 Corolla Navy Gunnery Site History Research**
One Time Request $43,000
Station Rank - 7 (Currituck Refuge Tier 2)
This project would provide the funding for a research study of the history of the Corolla Navy Gunnery Site on the Monkey Island Unit of Currituck Refuge. Nobody knows much about this historic use. Some unexploded ordnance is present and occasional passing storms uncover additional ordnance. There is a need for research into the extent of ordnance on the refuge to help determine the level of cleanup necessary and the level of public use that can currently occur in this area. Without this research, the refuge cannot plan development on this unit.

**Project 00018 Weekend Public Access Improvement**
First Year Request $65,000, Recurring Request $49,000
Station Rank - 7 (Mackay Island Refuge Tier 2)
This project would provide the funding to hire a public use specialist (outdoor recreation planner) to staff the Mackay Island Refuge headquarters and visitor contact station on weekends from April through October. Currently, the headquarters and the surrounding refuge area are closed on weekends for security reasons. This project would allow that area and the Kitchin Impoundment to be open for wildlife observation, wildlife photography, interpretation, environmental education, and outreach. The public use specialist would also manage the Currituck Refuge waterfowl hunts. Demand for public use activities is increasing every year. The demand would increase even more when the refuge develops the recreation facilities at the Kitchin Impoundment. The demand for weekend activity on the refuge is growing more than the demand for activity during the week. Failure to staff the headquarters on the weekend would limit our ability to provide wildlife-oriented recreation opportunities when the public wants them.

**Project 00019 Vehicle and Equipment Maintenance**
First Year Request $65,000, Recurring Request $52,000
Station Rank - 1 (Mackay Island Refuge Tier 2)
This project would provide the funding to employ an additional maintenance worker to maintain vehicles and equipment. As the staff and refuges increase in size, there would be additional needs for maintenance work. Currently, the two employees perform all the maintenance on the 12,000 acres of both Mackay Island and Currituck Refuges. They struggle at keeping up with the current workload. This position would allow the refuge to properly maintain vehicles and equipment, and allow the other two employees to concentrate on other maintenance needs. Failure to fund this project would limit the proper maintenance of vehicles and equipment.

**Project 00020 Newly Acquired Tract Posting**
One Time Request $20,000
Station Rank - 9 (Currituck Refuge Tier 2)
This project would provide the funding to post the boundaries of three newly acquired tracts on Currituck Refuge with signs. The tracts are: Currituck Marsh, Station Landing, and Ocean Associates. The project would fund signs, posts, and hardware. Currently, the staff has only posted a few signs in the more visible areas. Failure to post these areas would result in more violations and disturbance to wintering waterfowl.

**Project 02001 Administrative Management Improvement**
First Year Request $17,500, Recurring Request $25,000
Station Rank - 11 (Mackay Island Refuge Tier 2)
This project would provide the funding to employ a half-time office assistant to improve administrative operation and outreach for Mackay Island and Currituck Refuges. The staff for both refuges is six permanent and two seasonal employees. As the biological and public use programs expand, the workload would be more than one office assistant could handle. The current position handles budgeting, purchasing, time-keeping, and personnel, as well as all other clerical duties.

**Project 03000 Refuge Officer**
First Year Request $65,000, Recurring Request $71,000
Station Rank - 1 (Currituck Refuge Tier 2)
This project would provide the funding to employ a law enforcement officer. With the Department of Interior's mandated reduction in dual function officers, this refuge would have a lack of law enforcement presence. By providing an additional refuge officer to fill the void, the safety of the visiting public would be increased, as well as the refuge's ability to provide much needed protection for refuge natural resources and facilities. The addition of a full-time officer would provide a position whose primary responsibility is protecting the resource. Officer presence, surveillance, and visitor contacts are important to visitor safety and are critical in reducing crime on the refuge.

**Project 04001 Survey and Post Disputed Refuge Boundaries**
One Time Request $60,000
Station Rank - 2 (Currituck Refuge Tier 2)
This project would provide the funding to survey and post disputed refuge boundaries.

**Project 04002 Plan and Implement Big Game Hunting Program**
One Time Request $55,000
Station Rank - 4 (Currituck Refuge Tier 2)
This project would provide the funding to plan and implement a big game hunting program.

| Mackay Island National Wildlife Refuge<br>Refuge Operation Needs System (RONS) Projects Listed by Station Rank | | | | |
|---|---|---|---|---|
| **Station Rank/ Tier** | **Project Number** | **Cost (First Year, Recurring)** | **Positions** | **Project Title** |
| 1/1 | 99001 | 43K, 3K | | Phragmites Control |
| 2/1 | 97006 | 65K, 63K | 1.0 | Biological Program Enhancement |
| 3/1 | 00002 | 70K, 16K | | New Outreach Tools |
| 4/1 | 00006 | 41K, 35K | | Migratory Bird Management |
| 5/1 | 00014 | 18K, 4K | | Equipment Wash Rack |
| 6/1 | 00005 | 15.5K, 6.5K | | Water Quality Monitoring |
| 1/2 | 00019 | 65K,52K | 1.0 | Vehicle and Equipment Maintenance |
| 2/2 | 99004 | 58K, 25K | 1.0 | Administrative Management Improvement |
| 3/2 | 00009 | 85K, 69K | 1.0 | Fire Management Program Expansion |
| 4/2 | 97011 | 81K, 2K | | Fire Management Program Improvement |
| 5/2 | 99003 | 67K | | Forest Management Plans |
| 6/2 | 00003 | 60K | | Great Marsh Research and Restoration |
| 7/2 | 00018 | 65K, 49K | 1.0 | Weekend Public Outreach |
| 8/2 | 00013 | 75K, 74K | 1.0 | Exotic Nutria Control |
| 9/2 | 97009 | 80K | | Cultural Resource Survey |
| 10/2 | 00010 | 20K | | Fisheries Survey |
| 11/2 | 02001 | 17.5K, 25K | 0.5 | Administrative Management Improvement |

| Currituck Island National Wildlife Refuge<br>Refuge Operation Needs System (RONS) Projects Listed by Station Rank | | | | |
|---|---|---|---|---|
| **Station Rank/ Tier** | **Project Number** | **Cost (First Year, Recurring)** | **Positions** | **Project Title** |
| 1/1 | **97013** | 65K, 53K | 1.0 | Interpretation, Education, Outreach |
| 2/1 | **00001** | 65K, 53K | 1.0 | Refuge Endangered Species and Wetland Management Enhancement |
| 3/1 | **97002** | 140K, 22K | | Boardwalk, Observation Platform, and Trail Construction |
| 1/2 | **03000** | 65K, 71K | 1.0 | Law Enforcement Officer |
| 2/2 | **04001** | 60K | | Survey and Post Disputed Boundaries |
| 3/2 | **00016** | 25K, 40K | | Feral Horse Impact Research |
| 4/2 | **04002** | 55K | | Plan and Implement Big Game Program |
| 5/2 | **00011** | 65K, 69K | 1.0 | Refuge Management Improvement |
| 6/2 | **97004** | 130K, 56K | 1.0 | Habitat Improvement for Waterfowl and Shorebirds |
| 7/2 | **00017** | 43K | | Corolla Navy Gunnery Site History Research |
| 8/2 | **00012** | 20K | | Fishery Survey |
| 9/2 | **00020** | 20K | | Newly Acquired Tract Posting |

**MAINTENANCE MANAGEMENT SYSTEM (MMS) PROJECTS**

| Project Number | Project Name | Year Planned | Cost | Station Rank | Station Name |
|---|---|---|---|---|---|
| **94001** | Mackay Island Road Resurfacing | 2011+ | $342,000 | 25+ | Mackay Island |
| **95004** | Bulls Bay Bulkhead Replacement | 2009 | $129,000 | 12 | Mackay Island |
| **95005** | Bellows Bay Bulkhead Replacement | 2008 | $169,000 | 13 | Mackay Island |
| **96003** | Long Dike Resurfacing | 2011+ | $1,082,000 | 20 | Mackay Island |
| **96005** | Fire Cache Rehabilitation | 2005 | $51,000 | 1 | Mackay Island |
| **96008** | Mackay Island Road Resurfacing | 2011+ | $514,000 | 21 | Mackay Island |
| **97003 Old RONS** | Observation Platform and Fishing Pier Construction | 2011+ | $31,000 | 6 | Mackay Island |
| **97006** | Office Bulkhead Replacement | 2009 | $37,000 | 7 | Mackay Island |
| **97007 Old RONS** | Observation/ Photography Blind Construction | 2011+ | $31,000 | 8 | Mackay Island |
| **97007** | East Pool Parallel Dike Rehabilitation | 2007 | $32,000 | 8 | Mackay Island |
| **97008 Old RONS** | Electric Fence Construction | 2011+ | $70,000 | 25+ | Currituck |
| **97033** | Astro Van Replacement | 2004 | $31,000 | 25+ | Mackay Island |
| **99002** | Long Dike Repair | 2006 | $135,000 | 3 | Mackay Island |
| **99004 Old RONS** | Satellite Headquarters Construction | 2011+ | $204,000 | 9 | Currituck |
| **00003** | 1989 Blue Dodge Pickup Truck Replacement | 2004 | $28,000 | 25+ | Mackay Island |
| **00004** | Monkey Island Bulkhead Replacement | 2011+ | $1,200,000 | 1 | Currituck |
| **00008 Old RONS** | Fire Management Facility Expansion | 2011+ | $80,000 | 25+ | Mackay Island |
| **00011** | Office Entrance Road Rehabilitation | 2011+ | $131,000 | 25+ | Mackay Island |

| Project Number | Project Name | Year Planned | Cost | Station Rank | Station Name |
|---|---|---|---|---|---|
| **00015 Old RONS** | Additional Shop Bay Construction | 2011+ | $78,000 | 10 | Mackay Island |
| **00016** | Office Parking Lot Rehabilitation | 2011+ | $62,000 | 25+ | Mackay Island |
| **00017** | Office Entrance Road Rehabilitation | 2011+ | $274,000 | 25 | Mackay Island |
| **00018** | Refuge Headquarters Expansion | 2010 | $334,000 | 4 | Mackay Island |
| **01001** | Mackay Island Bulkhead Replacement | 2011 | $814,000 | 2 | Mackay Island |
| **01002** | 1998 Airboat Replacement | 2011+ | $27,000 | 17 | Mackay Island |
| **01003** | D-4 Dozer Replacement | 2011+ | $159,000 | 24 | Mackay Island |
| **01004** | Heavy Duty Disc Replacement | 2011+ | $10,000 | 25+ | Mackay Island |
| **01005** | Backhoe Replacement | 2011+ | $90,000 | 25+ | Mackay Island |
| **01006** | Tracked Marsh Vehicle Replacement | 2011+ | $94,000 | 16 | Mackay Island |
| **01007** | 14-Foot Rotary Mower Replacement | 2011+ | $14,000 | 4 | Mackay Island |
| **01008** | 16-Inch High Volume Lift Pump Replacement | 2011+ | $8,000 | 10 | Mackay Island |
| **01010** | 1996 4X4 Ford Tractor Replacement | 2011+ | $87,000 | 25+ | Mackay Island |
| **01011** | 1988 Case 585 Tractor Replacement | 2011+ | $47,000 | 14 | Mackay Island |
| **01012** | 1991 15 Ton Tilt Bed Trailer Replacement | 2011+ | $16,000 | 23 | Mackay Island |
| **01013** | 1998 Tilt Bed Trailer Replacement | 2011+ | $9,000 | 25+ | Mackay Island |
| **01014** | 1996 4X4 Dodge Dakota Replacement | 2011+ | $33,000 | 5 | Mackay Island |
| **01016** | 2001 Chevrolet Tahoe Replacement | 2011+ | $37,000 | 25+ | Mackay Island |

| Project Number | Project Name | Year Planned | Cost | Station Rank | Station Name |
|---|---|---|---|---|---|
| **01017** | 1999 Ford F-250 4X4 Truck Replacement | 2011+ | $26,000 | 22 | Mackay Island |
| **01018** | 1999 Ford F-250 4X4 Truck Replacement | 2011+ | $26,000 | 19 | Mackay Island |
| **01019** | 1995 Ford F-250 4X4 Truck Replacement | 2011+ | $26,000 | 11 | Mackay Island |
| **01020** | 1995 Ford F-150 4X4 Extended Cab Truck Replacement | 2011+ | $29,000 | 9 | Mackay Island |
| **01022** | East Pool Pump Replacement | 2004 | $40,000 | 25+ | Mackay Island |
| **02001** | New Office Building Construction | 2011 | $972,000 | 12 | Mackay Island |
| **02002** | Great Marsh Natural Hydrology Restoration | 2011 | $577,000 | 25+ | Mackay Island |
| **02003** | Visitor Contact Station/Research Facility Construction | 2011 | $313,000 | 5 | Currituck |
| **02004** | 18-Foot Boat, 60-HP Motor, and Trailer Replacement | 2011+ | $13,000 | 25+ | Mackay Island |
| **02005** | 2001 John Deere 670CH Motor Grader Replacement | 2011+ | $157,000 | 25+ | Mackay Island |
| **02006** | 2001 Kubota M8200 Replacement | 2011+ | $47,000 | 25+ | Mackay Island |
| **02007** | 2001 Alamo Side Mower Replacement | 2011+ | $8,000 | 25+ | Mackay Island |
| **02008** | 2001 Ingersoll-Rand RT 706H Forklift Replacement | 2011+ | $42,000 | 25+ | Mackay Island |
| **02009** | 1991 Chevrolet Fire Engine Replacement | 2011+ | $84,000 | 6 | Mackay Island |
| **02010** | Refuge Parking Lot Resurfacing | 2011+ | $42,000 | 25+ | Mackay Island |
| **02011** | 20-Foot Boat, 70-HP Motor, and Trailer Replacement | 2011+ | $16,000 | 25+ | Mackay Island |

| Project Number | Project Name | Year Planned | Cost | Station Rank | Station Name |
|---|---|---|---|---|---|
| **02012** | Proclamation Boundary Re-Survey and Posting | 2006 | $26,000 | 2 | Mackay Island |
| **03001** | Shop Entrance Road Rehabilitation | 2011+ | $95,000 | 25+ | Mackay Island |
| **03002** | Live Oak Point Road Rehabilitation | 2011+ | $435,000 | 25+ | Mackay Island |
| **03003** | Hog Pen Point Road Rehabilitation | 2011+ | $568,000 | 25+ | Mackay Island |
| **03004** | Cross Dike Road Rehabilitation | 2011+ | $317,000 | 25+ | Mackay Island |
| **03005** | Office Entrance Road Rehabilitation | 2011+ | $430,000 | 25+ | Mackay Island |
| **03006** | Five Refuge Parking Lots Rehabilitation | 2011+ | $57,000 | 25+ | Mackay Island |
| **03007** | Storage Building/Garage Construction | 2010 | $77,000 | 11 | Mackay Island |
| **04001** | 2003 Ford F250 Extended Bed Truck Replacement | 2011+ | $28,000 | 25+ | Mackay Island |
| **04002** | 2003 Freightliner 6X4 Stake Bed Dump Truck Replacement | 2011+ | $70,000 | 25+ | Mackay Island |
| **04003** | 30-Inch Pump and Bulkhead Replacement | 2011+ | $60,000 | 15 | Mackay Island |
| **04004** | Bunkhouse Replacement | 2011+ | $38,000 | 18 | Mackay Island |
| **04005** | Fire Cache/ Quarters Replacement | 2011+ | $400,000 | 7 | Mackay Island |
| **04005** | Residence Entrance Road Rehabilitation | 2011+ | $60,000 | 25+ | Mackay Island |
| **04006** | Shop Building Replacement | 2011+ | $600,000 | 3 | Mackay Island |

# *IX. Biological Review*

Fish and Wildlife Service
Wildlife and Habitat Management

Biological Review of
National Wildlife Refuges
of the Roanoke-Tar-Neuse-Cape Fear Ecosystem,
in Northeastern North Carolina and Southeastern Virginia

July 2002

**MACKAY ISLAND NATIONAL WILDLIFE REFUGE**

Mackay Island National Wildlife Refuge should utilize the existing 800 acres and develop additional managed wetlands, to eventually provide 1,025 to 1,225 acres of well-managed moist-soil and/or permanent water impoundments to help meet migrating and wintering needs of dabbling/diving ducks and other wetland birds.

Using sound professional judgment, consider providing as much open mudflat in impoundments as considered practical from mid-July to early-October for shorebirds. Conduct alternate drawdowns among impoundments as necessary within and among seasons.

As soon as possible, see that the 125-acre Kitchen Impoundment is restored, operational, and coordinated with the water management plans of the other impoundments.

In the long term (3 to 10 years), an additional 100 to 300 acres of managed wetlands (1 to 3 units) should be developed. Any ditched and drained wetlands or “prior converted” croplands that are acquired should be considered for meeting this objective.

Cooperative farming or contract/force account farming should be employed to ensure at least 75 to 100 acres of refuge share hot foods (corn preferred) are available for waterfowl.

Utilize USDA, NRCS-approved rotation of crops, focusing on corn, beans, and wheat. Ensure crop fields are open enough (wide enough) to attract geese and swans.

Support the North Carolina Sanctuary Areas. Work with ecosystem teams to give high priority to the hot foods, private landowners sanctuary program.

Work with adjacent landowners who have hunt sites surrounding the refuge to knock down their hot foods (corn) once the hunting seasons are over. Judge the possibility for refuge to help achieve this using refuge personnel and equipment.

Maintain the fields at Live Oak Point for goose browse production.

Spot surveys of submerged aquatic vegetation for affected open water areas and coordination with other State and Federal agencies on submerged aquatic vegetation monitoring programs.

Research is needed on the effects of boating disturbance (recreational and commercial) on wintering waterfowl and other seabirds.

No obvious changes from present management of emergent wetlands appear necessary. However, an extensive network of secretive marshbird survey routes should be established to help determine both status and response to habitat management across the refuge.

Monitor fire effects on the marsh vegetation.

A more detailed assessment (cruise) of forest resources is needed, but it appeared to the Team that it would be difficult to justify an active forestry program (i.e., administrating timber sales) at this time. Emphasis should be on improving stand structure and increasing hardwood component (while maintaining loblolly pine as a co-dominant).

Consider reforestation if co-op cropland comes out of production. Emphasize hardwood and particularly oaks in the plantings.

**Section 1.** Summary of Recommendations by Habitat Type

**MARINE/SOUND/BAY WATERS**

In Virginia, Back Bay National Wildlife Refuge and Mackay Island National Wildlife Refuge comprise an estimated 25 percent of the Back Bay water area, and comprise about one-third of the Back Bay watershed. Salinity in Back Bay is "borderline fresh-brackish," with salt concentrations of 1 to 3 parts-per-thousand (Data from Mackay Island National Wildlife Refuge during 2001 indicate range of 2 to 5 ppt, average of 3.4). This is the result of no nearby saltwater/ocean inlet, and the influence of numerous freshwater creeks emptying into Back Bay. Average bay depths range from 2 to 6 feet. Occasional "wind tides" are the only tidal influence in Back Bay. Strong, steady north winds will "blow out the bay," leaving mud/sand flats; while strong, steady south winds will fill and flood the bay, adjacent wetlands, and connecting waterways and ditches. The nearest ocean inlet is Oregon Inlet, North Carolina, 50 miles south of the Virginia-North Carolina border. Therefore, there is no lunar tidal influence in Back Bay. The predominant submerged aquatic vegetation species of Back Bay are Milfoils (*Myriophyllum* spp.), Sago pondweed (*Potamogeton pusillus*) and Widgeongrass (*Ruppia maritima*).

*Mackay Island National Wildlife Refuge Sound Waters*

Waters in Buck Island Bay, Little Bellows Bay, and Minger's Cove (portions of Currituck Sound), totaling approximately 185 acres, are included in the refuge boundary as a result of condemnation proceedings. A Presidential Proclamation Area of approximately 1,025 acres exists around the southern and western portions of the refuge in Currituck Sound and Back Bay. This area is closed to all waterfowl hunting.

Key management species are:

- American black duck
- Black scoter
- Atlantic brant
- Lesser scaup
- Canvasback
- Red-throated loon
- Common loon

Specific management recommendations are:

- Beached bird surveys are needed for exposed beaches on affected refuges and possible coordination with private landowners of adjacent beach properties.

- Research is needed on the effects of boating disturbance (recreational and commercial) on wintering waterfowl and other seabirds.

- Spot surveys of submerged aquatic vegetation for affected open-water areas and coordination with other State and Federal agencies on long-term submerged aquatic vegetation monitoring programs.

**FRESHWATER POOLS/PONDS/LAKES**

The following community types fall under this habitat type and should be identified as potential "Natural Communities" where they occur on refuge lands. Many of these will not be delineated in acreage figures at end of this document.

- Interdune Ponds
- Vernal Pools
- Oxbow Lakes
- Coastal Plain Semi-permanent Impoundment

This habitat type is a prominent habitat feature of the refuge and is characterized by shallow lake basins ranging from 0.5 to 6 feet deep. The source of water for these lakes is rainfall and surface runoff. Water pH ranges from neutral to slightly acidic. Submerged aquatic vegetation is an important habitat component. The most common type of submerged aquatic vegetation is wild celery, redhead grass, and musk grass. Slightly acidic lakes have little or no submerged aquatic vegetation.

Key management species are:

- American black duck
- Tundra swan
- Canada geese (migrant Atlantic population)
- Northern pintail
- Bald eagle

**MARSHES/GRASSLANDS**

The following community types fall under this category and should be identified as potential "Natural Communities" where they occur on refuge lands. Many of these will not be delineated in acreage figures at end of this document.

- Salt marsh
- Brackish marsh
- Freshwater marsh
- Tidal freshwater marsh
- Natural shoreline

**Marsh** - This category of habitat types includes brackish and freshwater marsh and associated high marsh, as well as moist-soil management areas and impoundments. The majority of marsh lies adjacent to the sounds at the refuge. Much of the natural brackish marsh has a natural fire frequency of 1-3 years, but has endured fire exclusion during the past half century or longer. As a result, much of the natural brackish marsh is suffering from a lack of species diversity as only one to three species of marsh grasses dominate the wetter or lower marshes, and encroaching brush has now dominated the high marshes. Large mats of thatch and storm debris have drifted up in long wide tide lines, suffocating large strips of marsh. Dead grass makes up a large component of the remaining marsh stands, limiting plant productivity and nutrient availability and adversely affecting wildlife habitat. Notable exceptions are the Mackay Island Refuge marshes that have been managed with fire for the past 30+ years. Invasion of phragmites has been a major problem in many of the marshes, with management of cattails being an issue primarily in some freshwater waterfowl impoundments. Control of these invasive species requires a combination of fire, mowing, flooding, and herbicide applications.

Key management species include the following:

- Red wolf
- American alligator
- Diamondback terrapin
- Peregrine falcon
- Black rail
- Black duck and other waterfowl
- Black bear
- Saltmarsh sharp-tailed sparrow
- Yellow rail
- Seaside sparrow
- King rail
- Clapper rail
- American bittern
- Least bittern
- Northern harrier
- Nesting and migratory shorebirds

Marshes are also vital nursery areas and habitats for many saltwater species, as well as some species of freshwater fish, crustaceans, and mollusks.

Specific management recommendations are:

- Burn 14,000 acres annually on a 1-4 year fire frequency to maintain or improve species diversity, improve plant productivity, and restore the high marshes to grasses.

- Explore alternate firing techniques to mimic natural wildfires in marshes (i.e., single point ignitions).

- Perform phragmite and cattail control where needed.

- Monitor effects of marsh burning and various firing techniques on “secretive marsh birds,” such as bitterns, rails, and sparrows. Use findings to make recommendations to mitigate impacts on these species in the future.

Monitor vegetation response to burning and that of the biotic community at large to adapt management techniques. (Issues: timing, frequency, prescriptive criteria of burns, etc.)

Mackay Island Refuge was established in 1960 and currently contains 8,138 acres. The primary purpose of the refuge is to provide sanctuary for wintering waterfowl. About 1/3 (30,000 to 36,000) of all snow geese (mostly greater), and up to half of the remaining 600 or so migratory Canada geese wintering in northeast North Carolina are supported in the vicinity of Mackay Island Refuge. About 1,000 tundra swans winter in the area. The vast majority of the refuge is in emergent wetlands, including some marshes with dead and dying trees, and open water supporting important beds of submerged aquatic vegetation. More than 300 acres are cooperatively farmed. Scattered small forest patches exist within the refuge, most along the eastern edge (Knotts Island), with some stands along the western edge (Currituck Sound, most notably Live Oak Point and the forested wetlands north of Middle Pool). The biggest threats include the rapidly developing private lands along the eastern edge of the refuge (Knotts Island) and the associated potential decline of water quality. Management priorities include restoration of sheet flow through the marsh into Currituck Sound that requires consideration of culverts under State Highway 615 and additional water control structures to increase water movement among pools. Major communities discussed were emergent wetlands, open water, and forests.

**Emergent wetlands.** Marshes range from good mixes of plant species to some areas dominated by phragmites and/or cattail. Despite the latter, most of the emergent wetlands appear to be in good to excellent structural condition and should support a good diversity of marsh-dependent species. Most emergent wetlands are burned on a 3-year cycle, or are managed by rising water levels. Description of firing protocols emphasized single-source ignition during late winter and early spring. This approach would seem to avoid unnecessary problems for bird species that may be vulnerable to multiple-ignition fires as conducted elsewhere. Document the results of fire by establishing vegetation monitoring transects and obtaining plant species, composition, and height data before and after fires on the marshes.

Specific management recommendations are:

- No obvious changes from present management appear necessary. However, an extensive network of secretive marshbird survey routes should be established to help determine both status and response to habitat management across the refuge.

- Monitor fire affects on the marsh vegetation.

- Explore opportunities with the States of Virginia and North Carolina to control certain navigable waters through a Memorandum of Agreement.

**Managed wetlands.** (Impoundments with canals and dikes that may include open water, moist soil, exposed flat, trees (greentree reservoirs) and emergent vegetation with varying amounts and management regimes)

*Background (Focus on Waterfowl in Roanoke-Tar-Neuse-Cape Fear Ecosystem)*

It is important to recognize from a landscape and flyway aspect the importance and role of the Roanoke-Tar-Neuse-Cape Fear Ecosystem for waterfowl (especially the refuges and State lands along and near the Atlantic Coast). Most of the data below will focus on North Carolina since Atlantic Flyway data is organized by states. However the point being made applies to the entire Roanoke-Tar-Neuse-Cape Fear Ecosystem, especially northeastern North Carolina and southeastern Virginia.

It is not uncommon for North Carolina (based on the Service/State mid-winter waterfowl survey) - to rank #2 and sometimes #1 regarding the total index of "dabbling" ducks within the entire Atlantic Flyway (a group of 17 States). Additionally, the Atlantic Flyway index to "pintails" demonstrates that North Carolina habitats overwinter at least 30,000 - 40,000 pintails that will approach 50-65 percent of the Flyway winter census total. North Carolina's wetland/open land habitats regularly have the highest pintail populations within the entire flyway.

Nowhere else in the Atlantic Flyway, nor other parts of the United States, does any one State overwinter so many tundra swans. North Carolina regularly provides wintering habitat for 63,000 to 83,000 swans, which has averaged 65-80 percent of the wintering Atlantic Flyway total.

North Carolina's Rank Among Atlantic Flyway States for Most Dabbling Ducks In Midwinter Inventory

| Year | Number Dabblers MWI | NC Flyway Rank |
|---|---|---|
| 1991 | 814194 | |
| 1992 | 702854 | |
| 1993 | 1074001 | |
| 1994 | 1431431 | |
| 1995 | 1100592 | |
| 1996 | 850023 | |
| 1997 | 668283 | |
| 1998 | 903462 | |
| 1999 | 1340002 | |
| 2000 | 878403 | |

Regarding migratory Canada geese, it is critical to recognize that in the southeastern states (North Carolina to Florida) the 500,000+ "migrant" Canada geese that once occurred in the Southeast are now practically gone in every State except North Carolina (a few hundred still occur in South Carolina). Currently, there are Flyway, Regional, and Ecosystem goals/objectives to try and reverse the loss of "migrant" Canada geese that traditionally overwinter in the southeastern United States. Presently, North Carolina hosts over 95 percent of such Atlantic Flyway migrant Canada geese (around 14,000) that occur below 37° latitude. It is important that these migrant geese do not decrease, but instead increase in numbers (or at least assure habitats "that are available" to accommodate larger numbers of migrant Canada geese).

Flyway-wide, snow/blue geese (i.e., white geese) are generally on the upswing and on some arctic habitats are exceeding population capacities. However, within this ecosystem area (North Carolina and other southeastern states) snow geese are not overly abundant, and if a flyway-wide attempt is made to drastically reduce the overall population, white geese numbers in the Southeast could easily go-the-route of the once numerous migrant Canada geese. Therefore, it is important that we consider an objective of accommodating approximately 60,000-70,000 snow geese, with the caveat that State densities exceeding 70,000 could trigger actions (i.e., special hunting seasons, modified agricultural practices) to reduce numbers in North Carolina landscape areas.

Additionally, other species of waterfowl occurring in North Carolina that are of concern on a flyway basis are black ducks and lesser scaup. Canvasbacks often bounce off/on waterfowl species-of-concern discussions, and wood ducks (due to lack of a nationwide survey index technique) are of high management interest. Some important roles of the refuges regarding these species need to be identified.

**Impoundments.** Vegetation structure and composition in the impoundments were good. Excellent waterfowl food was present and there was a good interspersion of open water. The present habitat management and water-level manipulation, as called for in the water management plans, should be followed. Continue with aggressive treatment of phragmites where they occur in the impoundments. Try to maintain a mix of moist-soil and submerged aquatic vegetation impoundments. This will be easier when the Kitchen Impoundment (125 acres) is refurbished, since there will be more options.

Based on discussions, good-quality northbound shorebird management should be available during peak migration periods from mid April to late May. The refuge should keep the need for bare to sparsely vegetated mudflats and shallow water (1 to 5 inches) in mind during this time period, as future water management plans are developed. Water levels were too high to observe shorebird use at the time of the Team's visit (true across the area). However, the Team felt that with "normal" water levels good shorebird habitat could be provided by late-summer drawdowns with little risk to waterfowl food production. For the East pool, the group recommended that a lower water level would have provided better growing conditions for moist-soil plants while they were in their seed producing stage, good shorebird foraging habitat, and an opportunity for emergent plant growth, such as bacopa, on some of the areas where the water was too deep for moist-soil plants, yet too shallow for submerged aquatic vegetation to thrive.

The refuge should utilize the existing 800 acres and develop additional managed wetlands to eventually provide 1025 to 1225 acres of well-managed moist-soil and/or permanent water impoundments to help meet migrating and wintering needs of dabbling/diving ducks and other wetland birds.

Specific management recommendations are:

- Using sound professional judgment, consider providing as much open mudflat in impoundments as considered practical from mid-July to early-October. Conduct alternate drawdowns among impoundments as necessary within and among seasons.

- As soon as possible, the 125-acre Kitchen Impoundment should be restored, operational, and coordinated with the water management plans of the other impoundments.

- In the long term (3 to 10 years), an additional 100 to 300 acres of managed wetlands (1 to 3 units) should be developed. Any ditched and drained wetlands or "prior converted" croplands that are acquired should be considered for meeting this objective.

**Farmland.** (May include moist soil, flooded cropland, mudflats, shallowly flooded crop residue, old field vegetation, and emergent vegetation)

It is best to have a mixture of hot foods (e.g., grains) grazing areas (e.g., browse) and moist-soil sites available in a relatively close area (with minimal daily disturbance) to truly meet the needs of ducks and geese. In North Carolina, the availability of high caloric foods (e.g., corn and milo) is severely reduced during critical periods (December, January, February) due to the practice of harvesting such crops in September or earlier (to reduce potential loss to hurricanes). A potential limiting factor for geese, swans, and to some extent, ducks, is this lack of hot foods in North Carolina during critical weather events. Additionally, the reliability of private landowners to provide water and sufficient sanctuary during hunting seasons is unknown. Private lands can and do play an important role in supplying life-history needs of migratory birds, but public lands (State/Federal) can and should provide a sufficient margin of reliable and long-term habitat/sanctuary needs to support waterfowl during critical periods and abnormally severe fall/winter seasons.

Woodcock have decreased nationally for the past decade and are still below flyway goals. Refuges need to determine whether they have woodcock present and, if so, initiate appropriate habitat management procedures to help meet the goals and objectives of the North American Woodcock Management Plan. Indication of woodcock presence and refuge use can be determined by counting/observing crepuscular flights during key months in fields.

At least twice during December, January, and February, conduct late evening or nocturnal (night lighting) surveys in the farmed field areas (FY 2002, 2003, 2004), to determine woodcock presence and use (repeat every 3 to 5 years).

Specific management recommendations are:

- The more open/pasture-like fields should be surveyed in late evening by placing several people around perimeter (especially fields near wood edges). Late evening (sunset to dark) flights (#of woodcock) should be recorded. Other preferred techniques are some night lighting in fields (count red-eyed contacts with woodcock).

- If woodcock are using fields for nocturnal usage, consider keeping some fields in an open-like, low-pasture or semi-plowed condition every year.

Maintaining winter browse and corn or other hot foods is important for geese and swans. The fields at Live Oak Point should be maintained for goose browse production. One suggestion is to sow Virginia wildrye, a native cool season grass, at Live Oak Point to provide browse. The cropland near the Headquarters is productive and also very accessible to geese/swan/ducks. That area is very important for providing corn/browse for wintering geese and swans. Every effort should be made to maintain a viable farming program that will allow continued production for geese and swans in these fields.

Specific management recommendations are:

- Cooperative farming or contract/force account farming should be employed to ensure at least 75 to 100 acres of refuge share hot foods (corn preferred) are available for waterfowl.

- Consider the following alternatives to ensure needed hot food acreages:

  Force-account some acreage;

  Contract farm some acreage;

  Use some combination of all the above;

  It may be possible for the refuge to supply fertilizer, approved herbicides, etc., and even execute first ground or site disking or plowing, and the cooperative farmer actually planting, maintaining, and harvesting the crop.

- Utilize NRCS-approved rotation of crops, focusing on corn, beans, and wheat. Ensure crop fields are open enough (wide enough) to attract geese and swans.

- Support the North Carolina Sanctuary Areas. Work with ecosystem teams to give high priority to the hot foods, private landowners sanctuary program.

- Work with adjacent landowners who have hunt sites surrounding the refuge to knock down their hot foods (corn) once the hunting seasons are over. Judge the possibility for the refuge to help achieve this using refuge personnel and equipment.

- The fields at Live Oak Point should be maintained for goose browse production.

**NON-MARITIME PINE/HARDWOOD/MIXED FOREST/HABITATS**

These community types fall under this category and should be identified as potential "Natural Communities" where they occur on refuge lands. Many of these will not be delineated in acreage figures at end of this document.

Forested habitats generally consisted of coastal fringe evergreen forest (1,329 acres) and a mixed loblolly pine and hardwood stand (131 acres). They consist of scattered patches in marsh areas that are dominated by loblolly pines and hardwoods consisting mostly of sweetgum. Most stands visited were in poor structural or compositional condition. Most stands (such as near the headquarters) had good understory development but little canopy (possibly due to water stress). The stands of loblolly-hardwood mix are limited to those areas between the marsh and the farm fields. Some stands visited (on east edge) had dense stands of tall loblolly pine alternating with dense understory of mostly exotic species. Some stands were clearcut based on southern pine beetle outbreak and are about 5 to 10 years away from any recommended silvicultural activity. Yet other stands dominated by merchantable loblolly were devoid of understory, but had some sweetgum as sub-canopy dominants. In almost all cases loblolly pine was the dominant species, but all stands probably could support a higher stocking of hardwoods. Given the small size and surrounding fragmented landscape, emphasis on landbird migrants would lead to emphasis on open stands with high abundance of fleshy-fruit bearing species, freshwater, and cover.

A more detailed assessment (cruise) of forest resources is needed, but it appeared to the Team that it would be difficult to justify an active forestry program (i.e., administrating timber sales) at this time. Emphasis should be on improving stand structure and increasing hardwood component (while maintaining loblolly pine as a co-dominant).

If existing co-op cropland becomes no longer necessary, reforestation would make now small patches into bigger patches, possibly large enough to support some of the higher priority forest songbirds.

Specific management recommendations are:

- Consider reforestation if cooperative cropland comes out of production.
- Emphasize hardwood and particularly oaks in the plantings.

**Section 2.** Biological Goals and Objectives for National Wildlife Refuges in the Roanoke-Tar-Neuse-Cape Ecosystem (covering northeastern North Carolina and southeastern Virginia)

**MARINE/SOUND/BAY WATERS** (185 fee title; 1,025 Proclamation Boundary)

**Goal -** Maintain the health of diamondback terrapin populations, migratory bird populations and habitat (submerged aquatic vegetation) quality in the bays, sounds, marine waters adjacent to refuge lands, especially within Presidential Proclamation boundaries.

**Objective** - Spot surveys of submerged aquatic vegetation for affected open water areas on refuges and coordination on large-scale and long-term submerged aquatic vegetation monitoring and water quality monitoring programs with other State and Federal agencies

**Objective** - Maintain existing submerged aquatic vegetation and work to restore submerged aquatic vegetation to areas where they have been lost in bays and sounds.

**Objective** - Within the framework of open hunting areas and navigable waterways, continue to enforce closed areas for waterfowl sanctuaries as much as possible.

**Objective** - Research needed on the effects of boating disturbance (e.g., recreational and commercial) on wintering waterfowl and other seabirds.

**Objective** - Beached bird surveys are needed along exposed beaches on refuges, which may include possible coordination with private landowners of adjacent beach properties to track possible linkages to contaminant spills, gill-net use, or other sources of mortality (including weather events), especially for loons, scaup, redheads, and scoters.

**Objective** - Develop monitoring protocol to track diamondback terrapin populations, including checking of crab-pots as sources of mortality.

**FRESHWATER POOLS/PONDS/LAKES** (770 acres)

**Goal** - Maintain and manage the health of migratory bird populations and habitat (submerged aquatic vegetation) quality in freshwater pools, ponds, and lake waters on refuge lands.

**Objective** - Monitor water quality on a periodic basis.

**Objective** - Spot surveys of submerged aquatic vegetation for affected open water areas and manage appropriately to maintain suitable to optimal conditions for wintering waterfowl and other waterbirds.

**Objective** - Control phragmites encroachment and other exotic pest invasions.

**Objective** - Conduct aerial waterfowl surveys and where possible count other waterbirds using a standardized approach (to be determined).

**Strategy** - Migratory Bird Field Office/Migratory Bird Committee: Develop standard protocol for aerial waterfowl surveys.

**MARSHES (predominantly Brackish and Fresh Water)** (4,774 acres, mostly fresh)

**Goal** - Manage marshlands to maintain a diversity of plant species and patchy structure for supporting priority birds (both waterfowl and nongame species), diamondback terrapin, and fisheries.

**Objective** - Survey using secretive marshbird protocol for occurrence of priority species to identify both sites that should be maintained as well as sites in need of improvement through management, principally for the following:

- American bittern
- least bittern
- yellow rail
- black rail
- clapper rail
- king rail

- saltmarsh seaside sparrow
- seaside sparrow

**Objective** - Burn marshlands annually on a 1- to 4-year fire frequency to maintain or improve species diversity, improve plant productivity, and restore the upland marshes back to grasses.

**Objective** - Explore alternate firing techniques to mimic natural wildfires in marshes (e.g., single point ignitions).

**Objective** - Perform phragmite and cattail control where needed.

**Objective** - Monitor effects of marsh burning and various firing techniques on "secretive marsh birds" such as bitterns, rails, and sparrows. Use findings to make recommendations to mitigate impacts on these species in the future.

**Objective** - Monitor vegetation response to burning and that of the biotic community at large to adapt management techniques. (Issues: timing, frequency, prescriptive criteria of burns, etc.).

**Objective** - Develop monitoring protocol for tracking diamondback terrapin populations.

**MANAGED WETLANDS** (i.e., impoundments with canals and dikes that may include open water, moist soil, exposed flat, trees, and emergent vegetation with varying amounts and management regimes, as well as management of vegetation on dikes and levees; 876 acres)

**Goal** - Manage and maintain impoundments to achieve habitat and migratory bird objectives for waterfowl, shorebirds, marshbirds, colonial waterbirds, other waterbirds, and associated landbirds**.**

**Objective** - Monitor water quality on a periodic basis.

**Objective** - Spot surveys of submerged aquatic vegetation for affected open-water areas and manage appropriately to maintain suitable to optimal conditions for wintering waterfowl and other waterbirds.

**Objective** - The refuge should utilize the existing 800 acres and develop additional managed wetlands, to eventually provide 1,025 to 1,225 acres of well-managed moist-soil and/or permanent water impoundments to help meet migrating and wintering needs of dabbling/diving ducks and other wetland birds.

**Strategy** - Using sound professional judgment, consider providing as much open mudflat in impoundments as considered practical from mid-July to early-October. Conduct alternate drawdowns among impoundments as necessary within and among seasons.

**Strategy** - As soon as possible, the Kitchen Impoundment should be restored, operational, and coordinated with the water management plans of the other impoundments.

**Strategy** - In the long term (3 to10 years) an additional 100 to 300 acres of managed wetlands (1 to 3 units) should be developed. Any ditched and drained wetlands or "prior converted" croplands that are acquired should be considered for meeting this objective.

**Objective** - Control invasive, non-desirable plant communities (alligator weed, phragmites, etc.), so they do not impact more than 10 percent coverage of any impoundment.

**Strategy** - Utilize chemical, fire, disking, water control, etc., to reduce impact of invasive/non-desirable plants.

**Strategy** - As appropriate, farmer cooperative rent should be used to control invasive plants.

**Strategy** - If poor quality waterfowl foods or invasive plants equal or exceed 50 percent of coverage, then extreme control measures are needed (even fall disking or multi-year deep flooding).

**Objective** - Recognizing personnel and budgetary limitations, work with and support migratory bird conservation efforts on nearby private lands. Contact/visit at least 75 percent of the adjacent landowners currently managing wetlands/forests, etc., for migratory birds and provide technical aid.

**Strategy** - Promote, encourage only 3 one-half days of hunting (or less) on private sites.

**Strategy** - Encourage landowners to keep holding water until mid-March or at least late-February for waterfowl and conduct slow drawdown. Where possible, hold water and draw it down slowly through April-early May for migrating wading birds and shorebirds.

**Strategy** - Via membership on ecosystem teams and whenever State meetings occur, give support and priority to the State/Federal/Private Land sanctuary area program and North Carolina Partners activities.

**Strategy** - After hunting seasons, if landowner's corn is still standing, work with him/her to recommend mowing or knocking down for better waterfowl use.

**Objective** - Meet wood duck banding quota and help band/observe swans and geese.

**Strategy** - Work to band your quota of wood ducks, with emphasis on June, July, August, and early-September periods and age/sex quotas. Record results in annual narrative.

**Strategy** - Each month (mid-October through early-March) help band and/or observe collared swans (FY 2001-2002).

**Objective** - Check and monitor wood duck box use at least twice a year (right before spring nesting period and after peak spring/summer nesting - probably July). If feasible, check boxes every 35 to 40 days during peak nesting periods (March, April, May).

**Strategy** - Review regional guidelines for data recording, or utilize other standardized date recording sheets. Show results in Annual Narrative.

**Strategy** - Remove boxes that are in poor condition, ensure all boxes have predator guards.

**Strategy** - If use of present boxes exceeds 60 percent, add up to 50 more wood duck boxes if personnel (volunteers, etc.), are available to clean and monitor boxes. Follow procedures in regional wood duck guidance.

**Goal** - All refuges should use scientifically sound inventorying/monitoring methods to survey numbers and trends of focus wildlife species, plant communities, and management programs. Properly recorded/archived data will be collected to (1) evaluate habitat management actions and wildlife responses, and (2) allow use of adaptive management procedures that improve subsequent management/restoration decisions.

**Objective** - Utilize standardized aerial and ground surveys to census waterfowl on all impoundments and aerial surveys to monitor Lake/Bay/Sound usage. Twice a month (preferred) conduct aerial counts (mid-October through mid-March) and twice a month conduct ground surveys of impoundments (early-October through late-March). Continue coordinating these surveys through Roanoke-Tar-Neuse-Cape Fear Ecosystem as is currently being done. Where possible, count other waterbirds using a standardized approach (to be determined). If possible, utilize weekly ground counts, including ground counts during the same week as the aerial survey.

**Strategy** - Continue to work with Migratory Bird Division pilot/biologists to cooperatively fly aerial surveys. Be sure and have refuge flown during the official mid-winter survey.

**Strategy** - Record ground survey data by individual impoundments or at least by impoundment units.

**Strategy** - All survey data should be available in refuge's annual narrative and entered into the website maintained by the Manteo Migratory Bird Office and Raleigh Ecological Services Office. Survey routes and techniques should be described and repeatable.

**Strategy -** If water is present in September, survey teal use.

**Objective** - Actively record biweekly water levels and plant germination progress in all managed impoundments during spring and summer to determine subsequent/follow-p actions.

**Strategy** - Prepare proposed water management plan for next year's actions.

**Strategy** - Utilize water gauges in all impoundments to record biweekly/monthly water levels (especially in early-spring/summer).

**Strategy** - Sample plant germination during early spring, identify dominant plant species, and modify management strategy as needed. Utilize the Migratory Bird Office biologist to help with surveys.

**Objective** - Record results of plant responses to impoundment management actions by conducting plant surveys in late-summer/early-fall. Determine coverage of preferred waterfowl plant species. Work with Roanoke-Tar-Neuse-Cape Fear Biologist Group to standardize survey methods and data analysis.

**Strategy** - Consult with Migratory Bird Office biologist to conduct standardized sampling of plant communities (record data in repeatable format).

**Strategy** - Present results in next year's water management plan and in annual narrative.

**Objective** - Survey using secretive marshbird protocol for occurrence of priority species to identify both sites that should be maintained, as well as sites in need of improvement through management, principally for the following:

- American bittern

- least bittern
- yellow rail
- black rail
- clapper rail
- king rail
- saltmarsh seaside sparrow
- seaside sparrow

**Objective** - Burn marshlands annually on a 1- to 4-year fire frequency to maintain or improve species diversity, improve plant productivity, and restore the upland marshes to grasses.

**Objective** - Explore alternate firing techniques to mimic natural wildfires in marshes (e.g., single point ignitions).

**Objective** - Monitor vegetation response to burning and that of the biotic community at large to adapt management techniques. (Issues: timing, frequency, prescriptive criteria of burns, etc.)

**Objective** - Control phragmite/cattail encroachment and control other exotic pest invasions.

**Objective** - Monitor effects of marsh burning and various firing techniques on "secretive marsh birds" such as bitterns, rails, and sparrows. Use findings to make recommendations to mitigate impacts on these species in the future.

**Objective** - Provide exposed mudflat for shorebirds in April and May and July through October (Acreage objectives should be guided by the Southeastern Coastal Plain-Caribbean Regional Shorebird Plan that gives goals for the Southeastern Virginia-North Carolina Region. These goals and a listing of the planned shorebird habitat for the current migration will be available on the South Atlantic Migratory Bird Initiative webpage).

**Objective** - Survey for foraging and roosting shorebirds during migration and winter using International Shorebird Survey protocol.

**Objective** - Record results of invertebrate responses to impoundment management actions by conducting surveys. Work with Roanoke-Tar-Neuse-Cape Fear Ecosystem Biologist Group to standardize survey methods and data analysis.

**Objective** - Manage vegetation along dikes as necessary for maintenance, but maintain flexibility for maintaining quality landbird habitat during migration as much as possible (especially at Pea Island).

**Objective** - For wooded areas/edges along dikes, track use of habitat during landbird migration using standardized migration monitoring protocol.

**FARMLAND (258 acres)**

**Goal** - Manage and maintain farmland, including fallow weeds, flooded crops, and moist soil, to achieve habitat and migratory bird objectives for waterfowl, shorebirds, marshbirds, colonial waterbirds, other waterbirds, and associated landbirds**.**

**Objective** - Woodcock. At least twice during December, January, and February, conduct late evening or nocturnal (night lighting) surveys in the farmed field areas (FY 2002, 2003, 2004) to determine woodcock presence and repeat every 3-to-5 years after 2004).

**Strategy** - The more open/pasture-like fields should be surveyed in late evening by placing several people around perimeter (especially fields near wood edges). Late evening (sunset to dark) flights of woodcock should be recorded. Other preferred techniques are some night lighting in fields (count red-eyed contacts with woodcock).

**Strategy** - If woodcock are using fields for nocturnal usage, annually consider keeping some fields in an open-like, low pasture or semi-plowed condition.

**Objective** - Employ cooperative farming or contract or force account farming to ensure at least 75 to100 acres of refuge share hot foods (corn preferred) are available for waterfowl.

**Strategy** - Consider the following alternatives to ensure needed hot food acreages:

- Force-account some acreage
- Contract farm some acreage
- Utilize some combination of all the above

**Strategy** - Utilize NRCS-approved rotation of crops, focusing on corn, beans, and wheat. Ensure crop fields are open enough (wide enough) to attract geese and swans.

**Strategy** - Support the North Carolina Sanctuary Areas. Work with ecosystem teams to give high priority to the hot foods, private landowners sanctuary program.

**Strategy** - Work with adjacent landowners who have hunt sites surrounding the refuge to knock down their hot foods (corn) once the hunting seasons are over. Judge the possibility for the refuge to help achieve this using refuge personnel and equipment.

**Strategy** - The fields at Live Oak Point should be maintained for goose browse production.

**Objective** - Conduct aerial waterfowl surveys and where possible count other waterbirds using a standardized approach (to be developed by Roanoke-Tar-Neuse-Cape Fear Biologist group).

**Objective** - Review existing refuge farmland acreage, determine what is necessary to achieve waterbird objectives and consider reforesting the acreage determined no longer necessary to achieve waterbird objectives.

**Objective** - Continue and expand North Carolina Partners Program in support of making seasonal habitat available for waterfowl.

**Objective** - Survey using secretive marshbird and/or Project Prairie Bird protocols for occurrence of priority species to identify habitat conditions that should be provided and maintained, as well as sites in need of improvement through management, principally for the following:

- American bittern

- least bittern
- northern harrier
- yellow rail
- black rail
- clapper rail
- king rail
- short-eared owl
- sedge wren
- sparrows (swamp, song, savannah)

**Objective** - Flood and disk vegetation as needed to maintain or improve species diversity and improve plant productivity for waterfowl and shorebirds, all the while maintaining rank vegetation that may be important for rails, wrens, and sparrows.

**Objective** - Monitor vegetation response to disking and flooding and that of the biotic community at large to adapt management techniques. (Issues: timing, frequency, prescriptive criteria of burns, etc.)

**Objective** - Monitor effects of various flooding and disking on "secretive marsh birds," such as bitterns, rails, and sparrows. Use findings to make recommendations to mitigate impacts on these species in the future.

**Objective** - Provide exposed mudflat for shorebirds April-May and July-October.

**Objective** - Survey for foraging and roosting shorebirds during migration and winter using International Shorebird Survey protocol.

**COASTAL FRINGE EVERGREEN FOREST (1,329 acres)**

**Goal** - Consolidate stands as much as possible and improve stand conditions by favoring hardwoods (while maintaining loblolly pine as a co-dominate) for a variety of species associated typically with hardwood forests.

**Objective** - Conduct a complete inventory of this habitat type and describe condition**.**

**Objective** - Where needed, improve structure by thinning canopy and allowing some level of understory and midstory development (i.e., de-emphasize fire unless hazard conditions dictate otherwise).

**Objective** - Monitor the biotic community response to thinning with emphasis on forest canopy species like yellow-throated warbler and understory species such as prothonotary and worm-eating warblers by using point counts.

**LOBLOLLY PINE/HARDWOOD MIX (131 acres)**

**Goal** - Consolidate stands as much as possible and improve stand conditions, by favoring hardwoods (while maintaining loblolly pine as a co-dominate) for a variety of species associated typically with hardwood forests.

**Objective** - Conduct a complete inventory of this habitat type and describe condition**.**

**Objective** - Consider reforestation of unneeded farmland and consolidate blocks of forest as much as possible.

**Objective** - Where needed, improve structure by thinning canopy and allowing some level of understory and midstory development (i.e., de-emphasize fire unless hazard conditions dictate otherwise).

**Objective** - Monitor the biotic community response to thinning with emphasis on forest canopy species like yellow-throated warbler and understory species, such as prothonotary and worm-eating warblers by using point counts.

**ADMINISTRATIVE AREAS**

**Goal** - Provide for efficient management access and care of equipment and safety of personnel. Wherever possible, work to reduce the numbers and widths of roads, firebreaks, and other administrative features that may contribute to habitat fragmentation and elevated depredation of bird nests.

**Objective** - Either maintain administrative buildings and maintenance areas off-refuge as much as possible or concentrate them in areas of already extensive open land on the refuge.

**Objective** - As habitats are restored, there may be a reduced need for maintaining existing road networks. Each refuge should plan accordingly.

**Objective** - Although many refuge lands temporarily require more frequent prescribed burning than would be recommended due to past fire suppression practices, after several cycles the numbers and widths of firebreaks should be reduced.